

NGM.COM OCTOBER 2010

# NATIONAL GEOGRAPHIC

# THE SPILL

## SPECIAL REPORT

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How the Gulf Works

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Brown Pelican,  
Fort Jackson Bird  
Rehabilitation Center

# COASTAL ECOSYSTEMS

The meeting of land and sea along more than 16,000 miles of coastline from Texas to Florida creates a wealth of ecosystems, from mangrove forests to coral reefs. The dynamic mixing of salt water and fresh water and the daily infusions of sediments from rivers nourish areas that provide habitat for wildlife and protection from pollution and storms.

## SALTWATER MARSHES

Tough grasses, like cordgrass, thrive in the intertidal zone, with its high salinity levels. Marsh grasses filter pollutants in the water and trap sediment to help build up land.

MARSH PERIWINKLES, feeding on grasses, regulate the growth of healthy marshes and serve as food for turtles, crabs, and birds.

## COASTAL PRAIRIES

An endangered ecosystem, coastal grasslands in Texas and Louisiana, fringed by marsh, accommodate migrating waterfowl, shorebirds, and songbirds.

## OYSTER BEDS

The Gulf's oyster beds are among the most productive in the world. Oysters filter water, and the reef structure provides habitat for many marine species.

## SHORELINE FORESTS

Coastal forests, including pine savannas and banks of live oak, form buffers between shoreline and inland ecosystems and offer vital stopovers for migrating birds.

## FRESHWATER RIVERS

Almost 60 percent of the U.S. watershed drains into the Gulf. River sediments have built up the Mississippi Delta, the largest coastal wetland in the lower 48 states.

## TURTLES

The Gulf harbors one of the world's greatest concentrations of turtle species. Five threatened or endangered sea turtle species lay their eggs on Gulf beaches.

## MANGROVE FORESTS

Mangroves provide a vital line of defense against waves, wind, and erosion. Brown pelicans and frigatebirds are among the many birds that nest inside.

## SEA GRASS MEADOWS

Lush meadows flourish in clear, shallow water. Manatees and sea turtles graze the vegetation, and shrimps, crabs, and juvenile fish shelter amid roots.

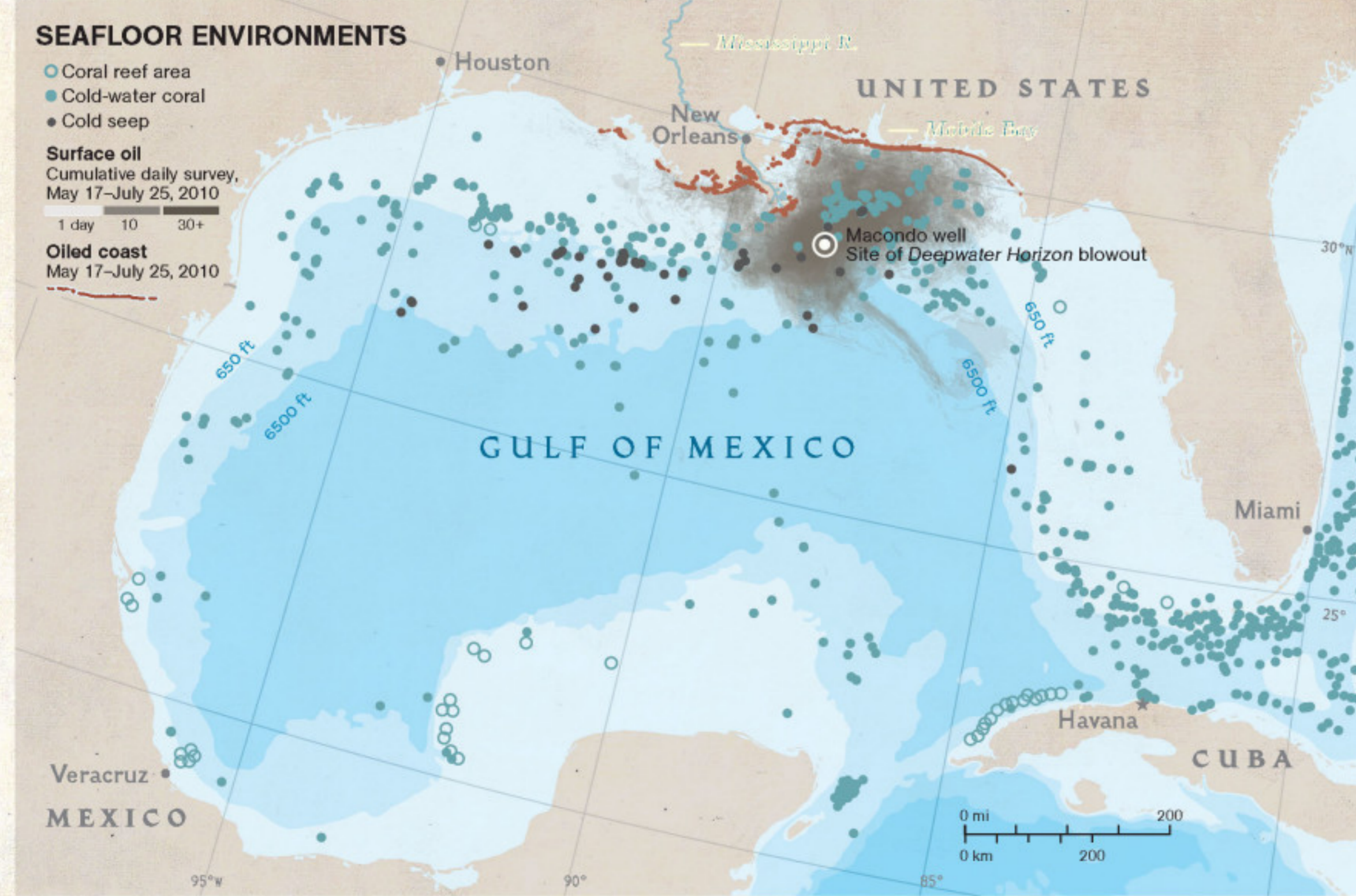
## SARGASSUM SEAS

Hundreds of thousands of acres are blanketed by floating seaweed that provides nurseries for many kinds of fish and habitats for hundreds of species, including shrimps, crabs, and snails.



# THE GULF OF MEXICO Layers of Life

The rich habitats of the Gulf of Mexico help make it one of the most ecologically and economically productive bodies of water in the world. Its environments range from sandy, ever shifting barrier islands to muddy, tide-washed marshes, from frigid dark zones miles deep to immense islands of floating seaweed. Even before the *Deepwater Horizon* rig explosion on April 20, 2010, which spewed millions of barrels of oil into the water, the Gulf was battling serious problems, including overfishing, extensive wetlands loss, and a huge oxygen-starved "dead zone" at the mouth of the Mississippi River. The oil spill is affecting every habitat, testing the Gulf's resilience.



SUPPLEMENT TO NATIONAL GEOGRAPHIC MAGAZINE, OCTOBER 2010  
ART DIRECTION AND DESIGN: SEAN MURPHY/STUDIO CITY ARTISTS; ART: ALDO CHAPPEL; TEXT: NANCY SAGE; AUTHOR: TIM CHESL; EDITOR: ART RESEARCH; KATHY N. WINDHAM; EDITORIAL RESEARCH: ANDREA GALLAGHER; ILLUSTRATIONS: ILLUSTRATION PRODUCTION; LARSON PUBLISHING; BILLY; SHOWBRIGHT; BEST MAP DATA: NOAA; CHUCK FISHER; PHOTODUPLICATION SERVICE; ELSA; WORKS; TERRY LINDSEY; ANDREW SCHWAB; DICK; CORAL REEF; SPINA; SAGE; WARE; RESEARCH INSTITUTE FOR GULF OF MEXICO STUDIES; MICHAEL BECK; ZACH FERRELL; AND WILLIAM FRENCH; THE NATURE CONSERVANCY; SAMANTHA; GUY; UNIVERSITY OF GEORGIA; PETER L. TRENDS; NATIONAL CENTER FOR COASTAL OCEAN SCIENCE; THOMAS; CHANDRABATI; CORONA STATE UNIVERSITY; MUSEUM OF NATURAL SCIENCE; FRANK; HERNANDEZ; DAN; PHIL; AND; SUE; LAU  
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# MARINE ECOSYSTEMS

Between its light-flooded surface and dark, barely explored depths, the Gulf's water world hosts an intricate web of life, from plankton to whales. Many inhabitants move between levels to feed. Others live on organic debris falling from above. Creatures composed mostly of water haunt the deep under crushing pressure, the darkness lit by bioluminescent hunters.

## BRIGHT SURFACE

Plankton drifting in the sunlit epipelagic zone create a rich soup to start the marine food chain. Plant plankton account for roughly half of Earth's photosynthesis, generating much of the atmosphere's oxygen. Many fish, crustaceans, and mammals, hiding in deep water by day, rise at night to feed.

## TWILIGHT ZONE

As sunlight fades, plants can't survive, giving way in the mesopelagic zone to an animal realm of predators, scavengers, and filter feeders. Many of its inhabitants feed on organic matter falling from above. The huge sperm whale passes through this zone, descending 3,000 feet and deeper to hunt squid.

## DARK AND TEEMING

In the bathypelagic zone, more than two miles deep at its outer limit, live animals that have adapted to extreme cold and pressure, including 20-foot-long elbowed squid, bioluminescent fish, and deep-sea jellyfish.

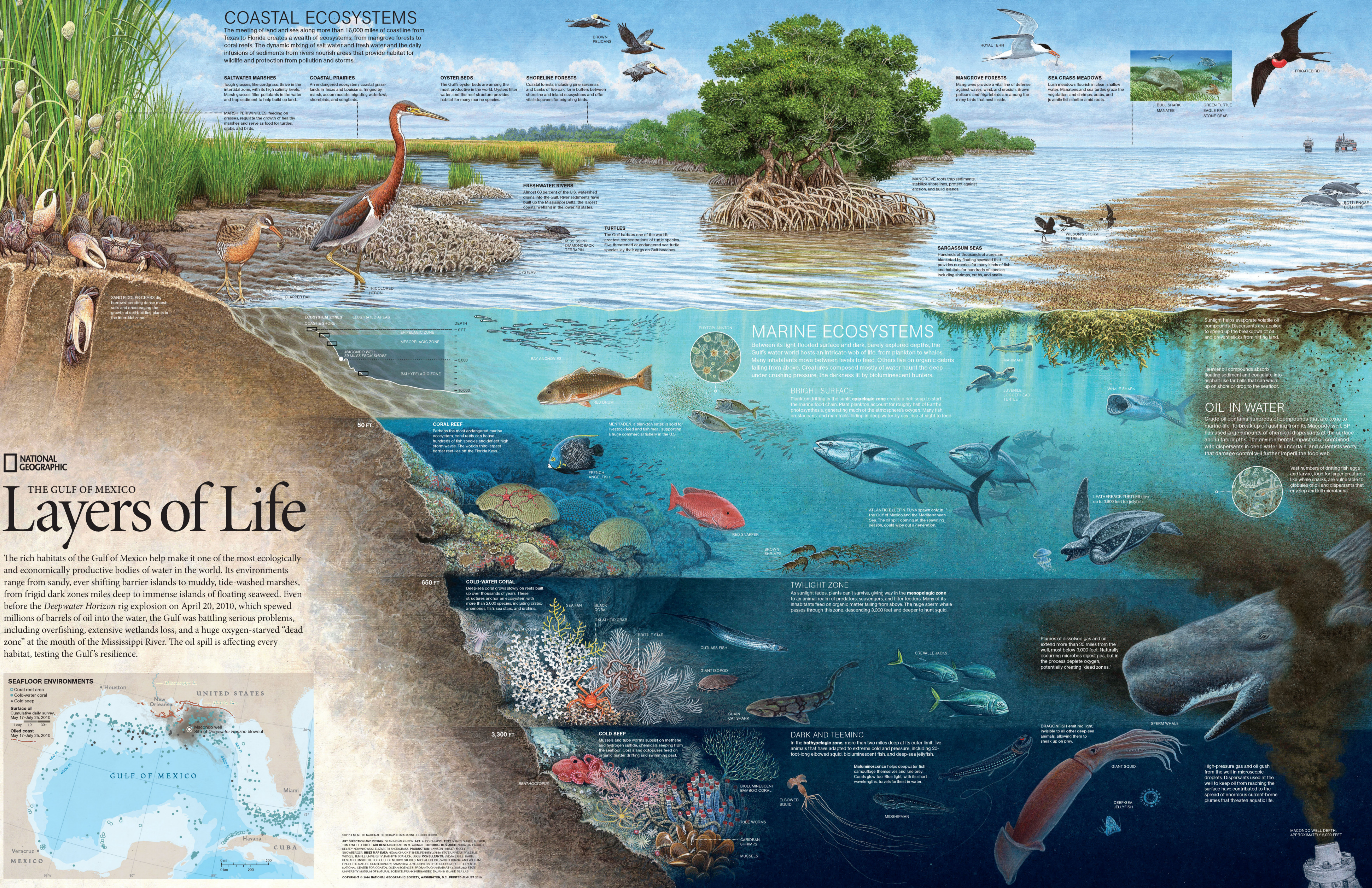
## OIL IN WATER

Crude oil contains hundreds of compounds that are toxic to marine life. To break up oil gushing from its Macondo well, BP has used large amounts of chemical dispersants at the surface and in the depths. The environmental impact of oil combined with dispersants in deep water is uncertain, and scientists worry that damage control will further imperil the food web.

Vast numbers of drifting fish eggs and larvae, food for larger creatures like whale sharks, are vulnerable to globules of oil and dispersants that envelop and kill microfauna.

Sunlight helps evaporate volatile oil compounds. Dispersants are applied to speed up the breakdown of oil and prevent slicks from hitting land.

Heavier oil compounds absorb floating sediment and coagulate into asphalt-like tar balls that can wash up on shore or drop to the seafloor.





**THE LOOP CURRENT**

The Gulf's largest current, the Loop Current, enters from the Caribbean as the Yucatan Current. Running to depths of 2,600 feet, it can swing directly east to join the Gulf Stream or surge north before curling back through the Straits of Florida. If it penetrates deeply into the Gulf, it often sheds a great eddy, which drifts westward. The Loop Current could carry oil from a Gulf spill up the Atlantic coast.

**ECONOMY OF THE U.S. GULF**

	Annual revenue (in \$ billions)	Jobs (estimated)
Oil and gas	62.7	107,000
Tourism	38.1	524,000
Commercial fishing	0.7	14,000
<b>Total</b>	<b>101.5</b>	<b>645,000</b>

SOURCES: OIL 2008; SEA TOURISM 2008; TOURISM DEPARTMENTS OF ALABAMA, LOUISIANA, MISSISSIPPI, AND TEXAS; FLORIDA DEPARTMENT OF REVENUE; FISHERY 2008; FISHERY VALUE 2008. \*2008 MOST RECENT AVAILABLE DATA FROM RELEVANT SOURCES



**OFFSHORE WELL PROFILES**

**TIBER**  
Water depth 4,132 ft  
Total depth 35,050 ft

**MACONDO**  
(Deepwater Horizon)  
Water depth 5,000 ft

**PERDIDO**  
Operating in deepest water 8,000 ft

**Map Legend**

- Coastal wetland
- Coastal protected area
- Active federal lease as of March 2010
- Shallow water
- Deep water (1,000 to 4,999 feet)
- Ultradeep water (5,000 feet or more)
- Oil or gas offshore platform
- Oil or gas well
- Crude oil or gas terminal
- Oil refinery
- Oil- or gas-related pipeline
- Maritime boundary
- Planning area boundary

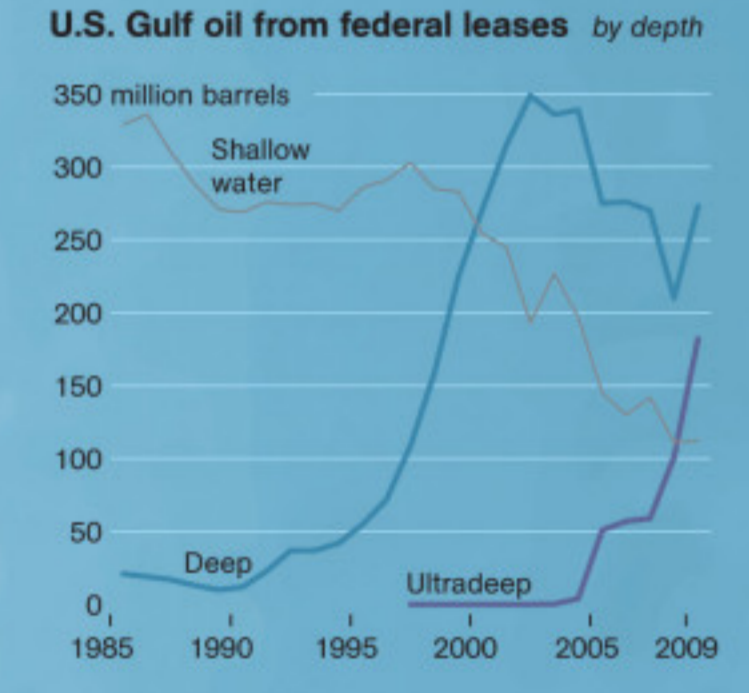
The maximum depth of the Gulf is unknown. Estimates range from 12,303 to 14,370 feet.



# Gulf of Mexico

**A GEOGRAPHY OF OFFSHORE OIL**

For the past half century, oil has driven the economy of the Gulf of Mexico. More than a third of U.S. oil production flows from nearly 3,500 platforms in the Gulf, with thousands of miles of pipeline delivering oil and natural gas to shore. Since the first Gulf well was drilled off Louisiana in 1938, in less than 15 feet of water, close-in reserves have been depleted and exploration has marched off the continental shelf, onto the continental slope, and beyond. Today Gulf oil is deep oil; the bulk of U.S. production draws from wells in more than a thousand feet of water. U.S. Gulf oil reserves are estimated at 44.9 billion barrels, but as the *Deepwater Horizon* disaster showed, the challenges of deep drilling are formidable.



**MEXICO'S OIL DROP**  
Daily output of Pemex, the state-owned oil monopoly, hit 3.4 million barrels in 2004 but has fallen to 2.6 million. The drop is blamed on poor management and declining close-in reserves. Three-quarters of the oil comes from the Gulf, where Mexico has estimated reserves of at least 11.3 billion barrels. Oil and gas sales fund a third of the federal budget; the U.S. is the top importer.

**IXTOC 1 OIL SPILL**  
Mexico's Ixtoc 1 well blew out in the Bay of Campeche in 1979 and flowed for 295 days. Some 3.5 million barrels of oil fouled hundreds of miles of shore as far as Padre Island, Texas. Most habitat recovered, but three-inch-thick tar mats remain in some lagoons. Ixtoc 1 ranked as the world's largest accidental marine spill until it was surpassed by Macondo.

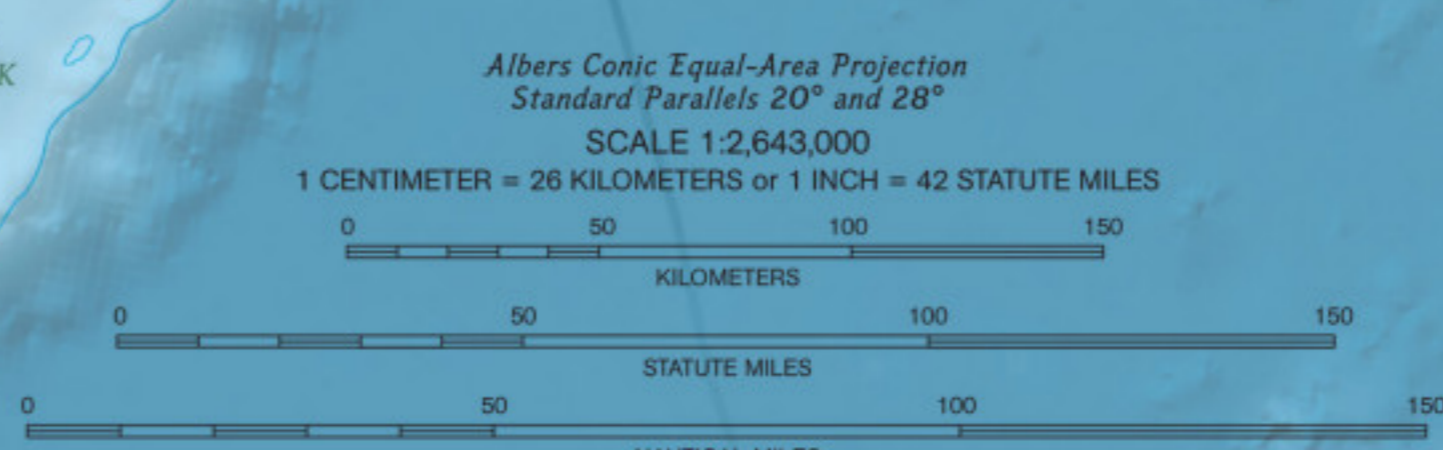
**DEEPWATER DISASTER**  
Working in 5,000 feet of water, the *Deepwater Horizon* rig had drilled 13,000 feet into the seabed when the exploratory Macondo well blew out on April 20, 2010. The explosion and fire sank the 58,000-ton mobile rig, killing 11 workers. An estimated 4.9 million barrels of oil flowed from the well, creating the worst accidental marine oil spill in history.

**U.S. PLATFORMS**  
A waterborne city of oil rigs rises off the coasts of Texas, Louisiana, Alabama, and Mississippi—but not Florida. Exploration off the Florida coast, starting in the 1940s, yielded largely dry holes, and the potential threat to the state's top industry, tourism, has been considered too great a risk.

**NEW DEPTHS**  
The world's deepest offshore well, the Tiber well (art. above) reaches nearly six miles below the Gulf's seafloor. Not yet operational, it was drilled in late 2009 by the rig *Deepwater Horizon*, which was destroyed months later drilling the Macondo well. Other record holders in the Gulf: The floating production platform *Perdido* operates in the deepest water—8,000 feet—and the Petronius tower, the tallest fixed platform, stands in 1,754 feet of water.

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SUPPLEMENT TO NATIONAL GEOGRAPHIC, OCTOBER 2010  
PRODUCED BY NATIONAL GEOGRAPHIC MAPS FOR NATIONAL GEOGRAPHIC MAGAZINE  
DESIGN: WILLIAM E. MCNULTY, JOHN BAXTER; TEXT: NANCY SHUTE; EDITORIAL RESEARCH: BRAD SCHREIBER, JOHN CASTELLO; ILLUSTRATIONS: BRAD SCHREIBER; EDITORIAL PRODUCTION: BELLY BUCKENBERG; MAP PRODUCTION: DEBBIE GIBSON; THESIS WHITE; MAP EDIT: MAUREN J. FLINN; MAP RESEARCH: DAVID MILLER; GIS: ROSEMARY GALEY; ART: BRYAN CHITRE; DIRT: BARRY BOBBER; SOCIAL MEDIA: JENNIFER WELLS; SYSTEMS: MARTIN ANDERSON; MANUSCRIPT MANAGEMENT: SHERIDAN, GIL, AND GAS INFRASTRUCTURES; GLOBAL LAKES AND WETLANDS DATABASE; WORLD WILDLIFE FUND (WETLANDS); DONALD R. JOHNSON; GULF COAST RESEARCH LABORATORY; UNIVERSITY OF SOUTHERN MISSISSIPPI; AND ALSO: SHERIDAN, GIL, AND GAS INFRASTRUCTURES; SEA AND MARINE INSIGHT; GROWING; SAUNDERS; VOSKOVITZ; NATURE RESEARCH INSTITUTE; TEXAS A&M CORPUS CHRISTI; JORDIG; IN PHOENIX, FLORIDA INTERNATIONAL UNIVERSITY  
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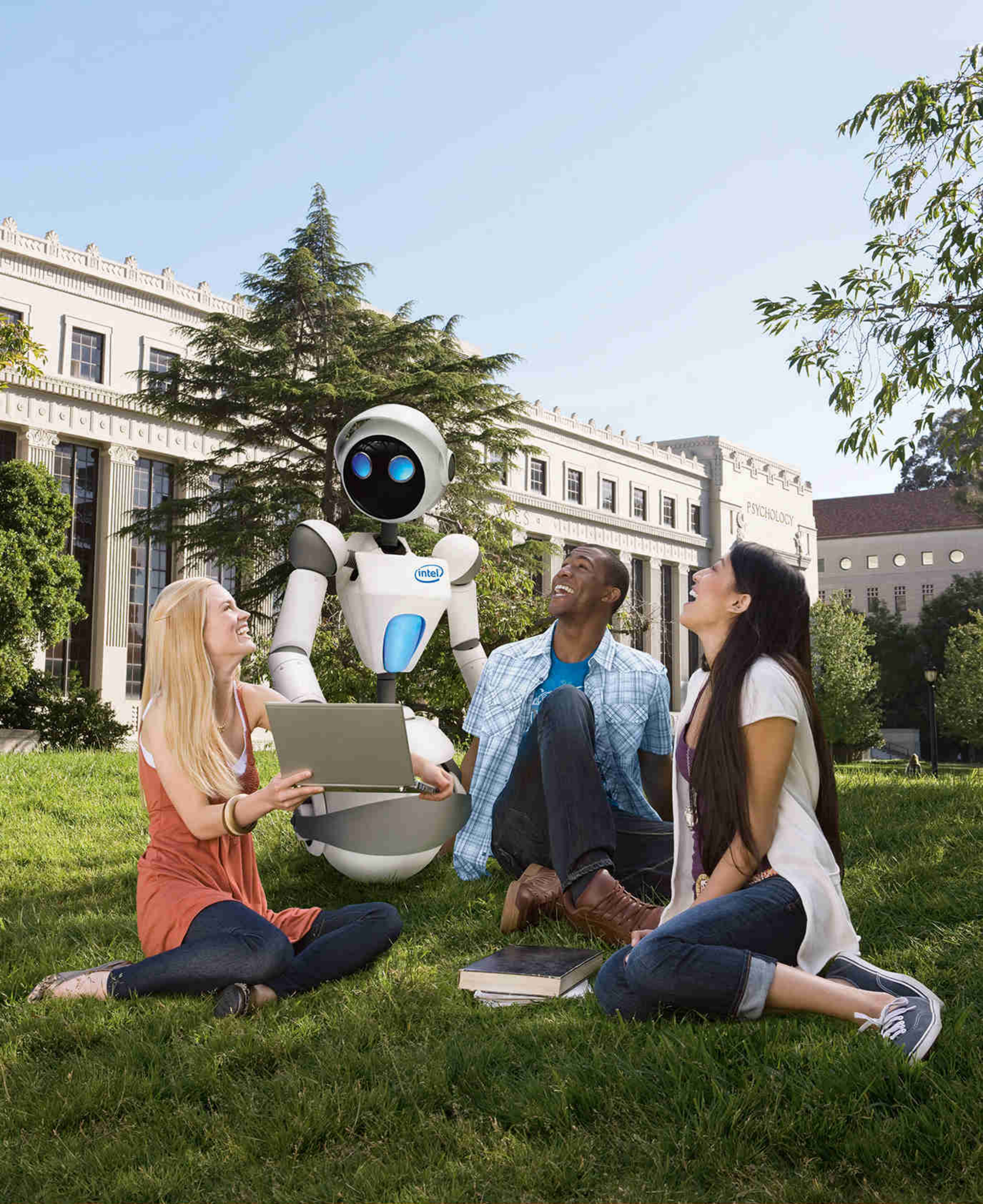


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# NATIONAL GEOGRAPHIC

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*By Paul Greenberg*
- Australia's Lost Giants**    **90** Jumbo kangaroos and ten-foot-tall birds once ruled the land.  
*By Joel Achenbach*    *Photographs by Amy Toensing*  
*Art by Adrie and Alfons Kennis*
- Being Jane Goodall**    **110** Her 50 years of work have made us rethink chimps.  
*By David Quammen*
- Allard's West**    **130** His camera captures cagey cowhands and sprawling skies.  
*Photographs and text by William Albert Allard*

**Special Supplement: Gulf of Mexico**



Stalwart sunbathers meet oil cleanup workers on the sands of Gulf Shores, Alabama. Story on page 28.

TYRONE TURNER

# NATIONAL GEOGRAPHIC

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### ENVIRONMENT

#### A Less Trashy Everest

The "death zone" holds 60 years' worth of dumped gear. Now the cleanup begins.

### GEOGRAPHY

#### Record Hail

Hailstones aren't easy to make, but they fall with abandon in Kenya and are as big as eight inches across in the U.S.

### OCEANS

#### Too Many Fish to See

A \$650-million survey is creating a census of crabs, sea squirts, lampshells, and more.

### HEALTH

#### How Much Water Do You Need?

Hydration experts think the "eight 8-ounce glasses" dictum doesn't hold water.



### THE BIG IDEA

#### Scanning for Posterity 24

Laser devices are making detailed images of landmarks to aid in any future restoration.

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GeoPuzzle

### On the Cover

On June 14, the rehab center caught the oiled brown pelican. After a bath—"they must think we're trying to kill them"—it was released July 1.

Photo by Joel Sartore



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#### Goodall in Print

National Geographic has long supported the work of the self-described "strange hairless primate." We've assembled an archive of the magazine's articles by and about her.

MICHAEL NICHOLS, NGM STAFF



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**It is 150 years, seven months,** and 24 days from the day, August 27, 1859, when Edwin Drake drilled the first successful oil well near Titusville, Pennsylvania, to the blowout of the *Deepwater Horizon* oil rig, 48 miles off the coast of Louisiana, this past spring.

Drake's well, which struck oil at a depth of 69.5 feet, launched the modern oil industry. We have been dealing with the consequences of our petroleum-fueled lifestyle ever since. There's been much finger-pointing and debate over who is to blame for the stain of oil in the Gulf of Mexico, but the fault can be said to lie in no small part within ourselves and our appetite for oil. It is an appetite that Drake, with his 20-barrel-a-day well, could not have imagined. The oil from that well, and others of that era, went mostly into kerosene, which was replacing whale oil for lighting. Henry Ford's company, which would ultimately put car keys in millions of hands, was nearly half a century away. Petroleum-based polymers, plastic bottles and bags, fertilizers, jet planes, the Age of Hydrocarbon Man, as Daniel Yergin calls it in *The Prize*, his history of oil, had not yet arrived.

The words that follow in this month's issue, and the photographs—an oil-soaked pelican, a tarry shoreline, the despair on fishermen's faces—remind us that there is more to the cost of oil than the ticking numbers at the fuel pump.

An oily wave breaks on the beach at Gulf Shores, Alabama.

A handwritten signature in black ink, reading "Chris Johns". The signature is stylized and cursive.



▲  
Afternoon on a Barcelona street.

Shot using the Samsung NX10  
with 18-55mm lens, f/2.8,  
ISO 400, 1/60 exposure.



**LANDON  
NORDEMAN**

Landon Nordeman is a photographer based in New York City. His assignments have taken him from Austria to Australia, Buenos Aires to Budapest, Nebraska to New Zealand. In addition to his work for *National Geographic*, Nordeman has produced award-winning photographs for national and international publications such as the *New Yorker*, *Smithsonian*, *The Atlantic Monthly*, *Sports Illustrated*, and *Saveur*.

## A Glimpse of Barcelona

From Gothic buildings that stand in stony silence to the warped and wonderful structures of Antoni Gaudí, Barcelona is a diverse, dynamic, and dazzling city. Adding to the mystique of this historic metropolis are its people—a blend of Catalan and Spanish that creates a vibrant culture infused with fire, music, and a fiercely independent spirit.

In fact, when *National Geographic* photographer Landon Nordeman traveled to Barcelona, with his Samsung NX10 camera in tow, it was the people of Barcelona that most captivated his attention, as evidenced by this shot.

Referring to his inspiration for making the portrait, Nordeman says: "What drew me to him was not only his personal style, but also his haircut and mustache. He is clearly a sharp dresser. The key moment here is in his gesture of looking over his shoulder down the street. It seems to me that he is waiting for something, and that sense of anticipation is what makes the photo work. It gives it a sense of mystery."

Nordeman says that the superfast autofocus ability of the NX10 came in quite handy while creating this candid shot by allowing him to freeze a moment in motion; the NX10 instantly allowed him catch the Spanish gentleman mid-pose. Nordeman also adds that "the camera performed well here by capturing the subtle variance in colors."



### NX10

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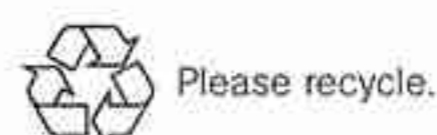
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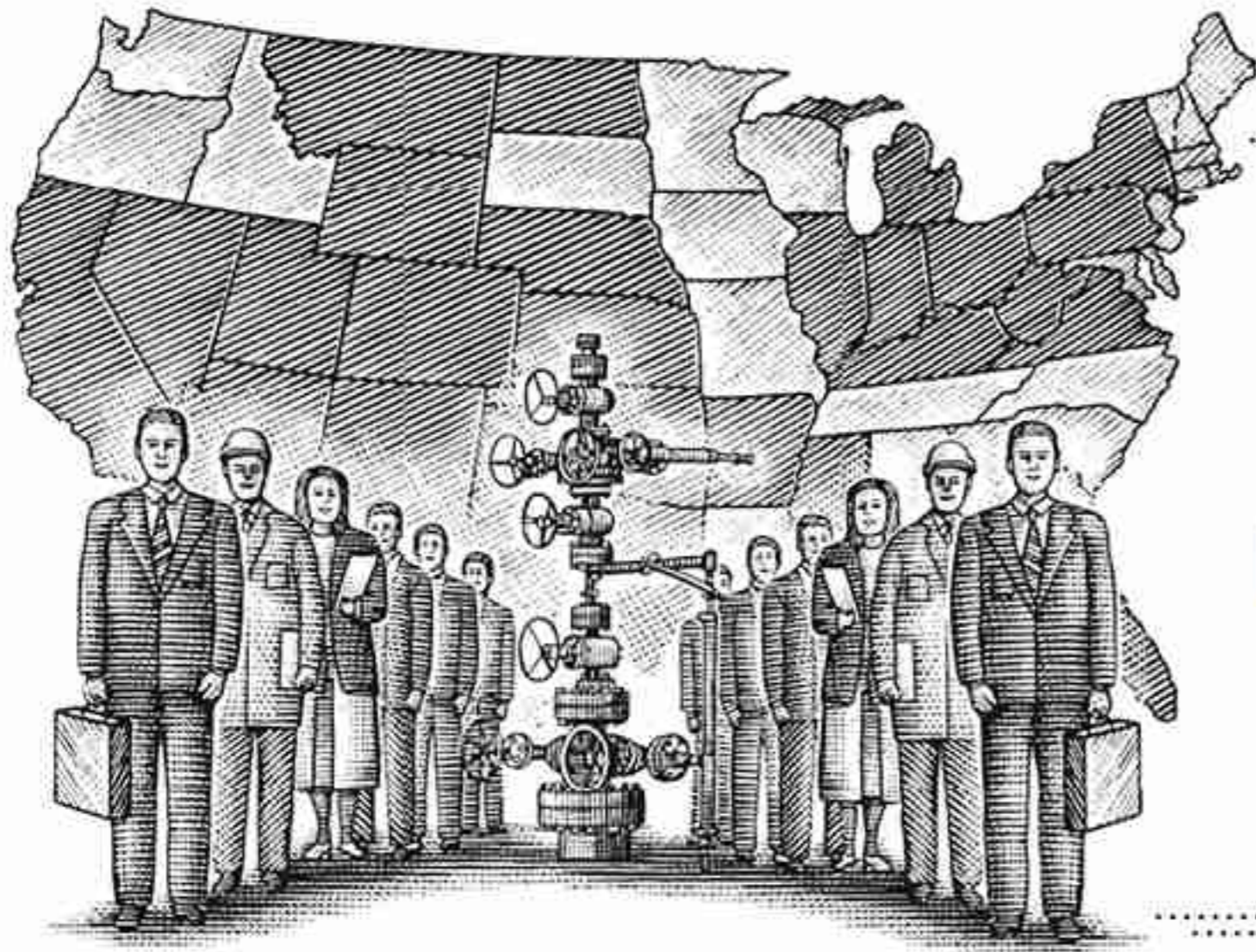
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DID YOU KNOW ▶

NATURAL GAS IS A POWERFUL JOBS ENGINE.

From the earliest days of "The Great Recession," economists have warned of a "jobless recovery."



**105,000  
NEW JOBS**

However, natural gas jobs are up by 17% in just two years.

**WHAT YOU NEED TO KNOW  
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Take a long, hard gaze out across the American economic landscape. If you were part of a local Chamber of Commerce right now, what would a new factory in town mean to your community? How much excitement would herald its arrival?

This is precisely what is happening in the 32 states that produce American natural gas.

Each new rig that appears on the horizon is more than a temporary piece of machinery – it is an employment and local wealth creation engine. Today, natural gas supports nearly 3 million U.S. jobs, and this sector of the energy community is rapidly expanding with direct employment up by more than 105,000 in just two years. And being a technology-driven and capital-intensive endeavor, these are high-paying, quality jobs – right when we need them most.

**WHAT ARE WE WAITING FOR?**

**PUT AMERICAN NATURAL GAS TO WORK FOR AMERICA NOW.**

**The consensus is clear.**

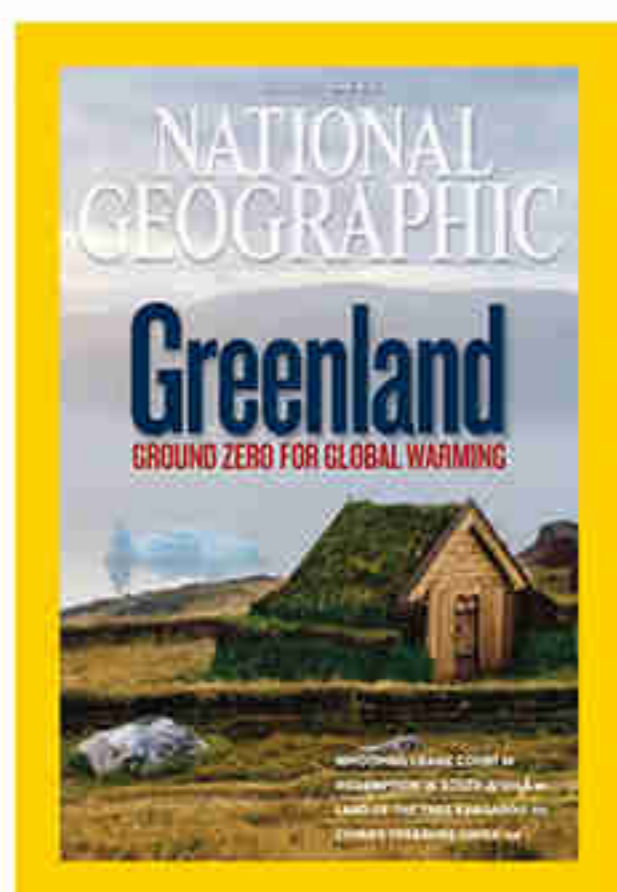
Economists, academics, business leaders and politicians nearly all agree the U.S. economy in the 21st century must be built around clean energy. This is where the jobs are.

**WANT MORE JOBS?  
PRODUCE MORE NATURAL GAS.**

Natural gas is one of the only clean energy sources that is large enough, and has enough demand to give tens of thousands of Americans steady new work. In fact, the value added to the U.S. economy from direct natural gas jobs was \$172 billion in one year alone.



[www.cleanskies.org](http://www.cleanskies.org)



June 2010

## Greenland

Your article showed the challenges of agriculture in Greenland. However, it's a bit unfair to knock Greenland's farms for importing fodder from Europe. The European Union is highly dependent on imports for feeding its livestock. Over 50 percent of the EU's protein feed is imported; it is largely soybeans from the Americas. Better that Greenlanders develop their agriculture than become dependent on drilling for oil off the coast.

**HERB S. ALDWINCKLE**  
 Professor of Plant Pathology  
 Cornell University  
 Geneva, New York

While Greenland citizens' optimistic view of oil and rare earth profits is understandable, it should be tempered by recent realities. The deaths of miners in China and West Virginia and the disaster in the Gulf of Mexico should warn of the possible price. The thousand-year tradition of fishing and farming could end tragically, with the newly wealthy populace sopping up oil or digging out buried friends and relatives.

**DALE BARTOLETTI**  
 Salinas, California

## China's Caves of Faith

To the foreign curators who contend that "their museums have saved treasures that might otherwise have been lost forever—destroyed in the wars and revolutions of 20th-century China," I want to say, Thank you very much for your unselfishness. Now, can we have those back for 21st-century China? And by the way, it's not "some Chinese officials" who call for the artifacts to be returned. It's the Chinese people.

**XIANG ZHUANG**  
 Buffalo, New York

## Mandela's Children

Born in Cape Town in 1993, I belong to one of many South African families who left the country to escape the violence that followed the confusion of the regime change. I doubt I am the only one who misses the friends, family, and country that were left behind. But every time I hear stories of the violence in the country from relatives and friends who still live there, I feel any hope that the country may change slip away. Your article, "Mandela's Children," is incredibly heartening. While violence and prejudice still exist in the country, the article's take on the forgiveness of those involved in the bomb attack, not to mention the relaxing racial attitudes of others, gives me hope. It's hope that the time is coming when this beautiful country can be proud of what it has achieved—a time when everyone can really be equal. Change doesn't happen overnight, but perhaps sometime soon South Africa will have left its troubles behind. I look forward to that day.

**LOUISE FRASER**  
 Tunbridge Wells, England

Before reading this, I was skeptical about South Africa overcoming the consequences of apartheid, to say nothing about its unemployment rates and sky-high number of AIDS cases. After reading this, I began to understand the role of South Africa in this world. It is a beacon of hope for all the nations torn apart by violence and hatred.

**FABIOLA RODRIGUEZ**  
 Texcoco, Mexico

## The Big Idea: Earthquake Engineering

The article proposed wooden-trussed metal roofs for reconstruction in the earthquake-prone Port-au-Prince area. I live in a small Turks and Caicos community that is roughly 30 percent ethnic Haitian, so all residents of the village were affected by the Haitian earthquake. Some American friends recommended that the Haitians rebuild their homes with wood-frame roofs instead of concrete. But in Haiti, the owner of such a house is perceived as poor. Concrete roofs are preferred as a status symbol in a country where conspicuous consumption is hard to come by. Lighter roofs are more practical for economic and safety reasons, but any imported ideas for future improvements must pass often unexpected tests of local cultures.

**B. NAQQI MANCOS**  
 Kew, Turks and Caicos Islands

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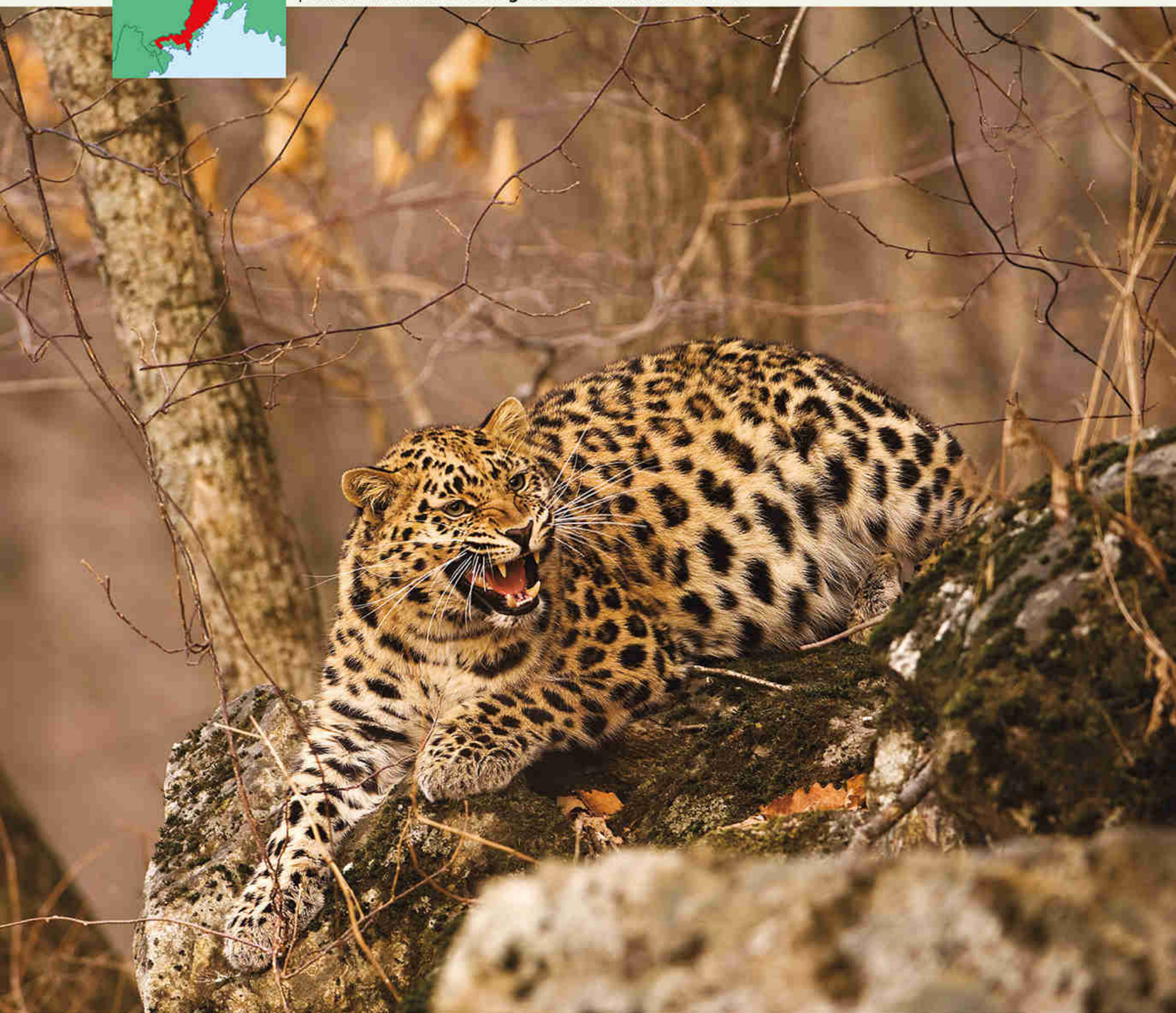
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**Amur Leopard** (*Panthera pardus orientalis*)

**Size:** Head and body length, 100 - 145 cm (39.4 - 57.1 inches); tail, 80 - 85 cm (31.5 - 33.5 inches)

**Weight:** 30 - 60 kg (66.1 - 132.3 lbs) **Habitat:** Temperate deciduous forest in the southern Primorye province of Russia **Surviving number:** Estimated at 30 - 35



Photographed by Andrew Harrington

# WILDLIFE AS CANON SEES IT

Elusive. Enigmatic. And very nearly extinct. The Amur leopard remains something of a mystery; what we know of its life in the wild has largely been pieced together by researchers who follow its tracks in the snow. The northernmost of the leopards, it grows a long, thick coat to cope with winter temperatures as low as -22°F. A formidable predator, it preys mainly on deer and wild boar, though it will hunt smaller animals as well. The leopard is itself prey to

poachers, however, putting terrible pressure on a population also struggling with habitat loss. And because numbers are so desperately low, it wouldn't take much to push the leopard over the edge.

As we see it, we can help make the world a better place. Raising awareness of endangered species is just one of the ways we at Canon are taking action—for the good of the planet we call home. Visit [canon.com/environment](http://canon.com/environment) to learn more.

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## LETTERS

My wife and I worked for a week in Haiti in June 2001 and watched a flat roof being constructed with a mixture of cement, sand, and river water. The author states that a lightweight, metal roof on wooden trusses would be more resilient. While true, this might lead readers to believe that Haitians were ignoring a simple solution. In fact, there are a number of good reasons for the flat roofs. Many Haitian houses are built this way with the intention that a second floor will be added later as the family grows. The roof will become a floor later. People also use the flat roofs to collect rainwater and store it in cisterns. While a sloped roof can also collect rainwater, lightweight metal roofs are expensive and may corrode in acid rain. They're also hotter than concrete and would blow off during the hurricanes.

**LAWRENCE J. BENNETT**  
Boise, Idaho

The idea of a light, cheap roof in Haiti sounds great until a hurricane blows through, which in Haiti will likely happen long before the next earthquake. I saw firsthand how well this innovation played out in Florida. How about designing a light, cheap roof that resists both seismic and wind events?

**TOM JONES**  
Garland, Texas

### **Environment:**

#### **A Day With Less Driving**

On Memorial Day 2010, while I sat in ten-mile-an-hour traffic with hundreds of others on the New Jersey Turnpike, I thought of Marc Silver's article on eco-commuting. My trip on most other days would have taken about three hours. This day's trip took six. Why do we create high-speed venues that encourage us to travel rapidly and then encumber our commutes with delays at toll barriers and on narrow highways? I wonder if the cost of collecting revenues to maintain these venues outweighs the ultimate cost to our ecosystem.

**WILLIAM S. BERNFELD**  
Smyrna, Delaware

**Freeze Frames** Winter may not be here yet, but chillingly good images are always welcome in *National Geographic*. If you've taken an amazing shot—of a traditional game, a top-of-the-world vista, or most anything at all—let us take a look; we just might publish it here. Every month this page features two photographs: one chosen by our editors, one chosen by our readers via online voting. For more information, go to [ngm.com/yourshot](http://ngm.com/yourshot).



EDITORS' CHOICE

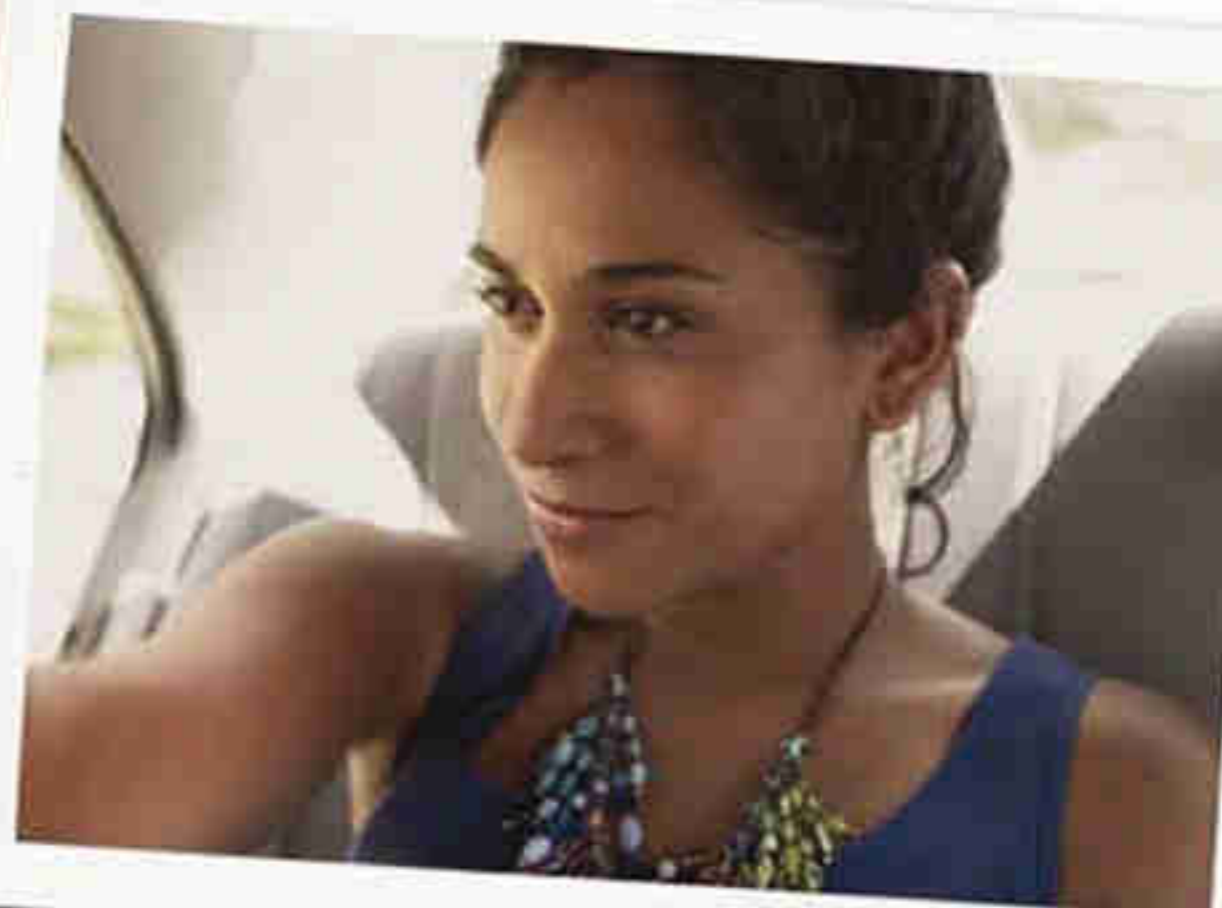
**Andrew Davison** Arvayheer, Mongolia  
 An Australian living in Mongolia, Davison, 32, braved  $-22^{\circ}\text{F}$  temperatures to witness an annual ice festival held on frozen Lake Hovsgol. One of the events was this game, called *musnii shagai*. It involves two teams skimming animal bones toward red targets.

**Brenton Spies** Simi Valley, California  
 Just over halfway up Alaska's 20,320-foot-tall Mount McKinley—the highest peak in North America—Spies, 26, glimpsed this stunning view. Despite the blue skies, says Spies, the temperatures here stayed below  $0^{\circ}\text{F}$ ; the winds reached 80 miles an hour.



READERS' CHOICE

NEW CAR. NEW START.



My Corolla is the first new car I've purchased. So it was a huge deal for me. It's the biggest investment I've ever made. It just feels like a really reliable, safe car. After I bought it, I drove the five-hour trip from my parents' house to my place in LA. It was very peaceful, and I felt like I'm actually becoming an adult. You know what I mean? Like a rite of passage.

Susie Abraham  
2010 Corolla Owner



Every Toyota has a story.

The 2010 Corolla – a 2010 Top Safety Pick from the Insurance Institute for Highway Safety.\*

Share your story at [facebook.com/toyota](https://www.facebook.com/toyota)

Thanks for your story, Susie!



\*Insurance Institute for Highway Safety 2010 rating for Corolla, vehicle class Small Cars. Ratings are only meaningful when comparing vehicles in the same class. 2010 model year tested. For more details on 2010 Top Safety Pick Awards, see [www.iihs.org](http://www.iihs.org) ©2010 Toyota Motor Sales, U.S.A., Inc.

VISIONS OF EARTH



**United States** Lunar light bursts into view beneath Arch Rock, a 12-foot-tall, 30-foot-wide granite formation in California's Joshua Tree National Park. Naturally beige, the rock is illuminated here by a red LED.

PHOTO: JIM PATTERSON PHOTOGRAPHY



**United States** Nearly camouflaged on the debris-strewn bottom of Florida's Lake Worth Lagoon, a six-inch-long male jawfish holds hundreds of eggs in its mouth—a five-day incubation process called paternal mouth brooding.





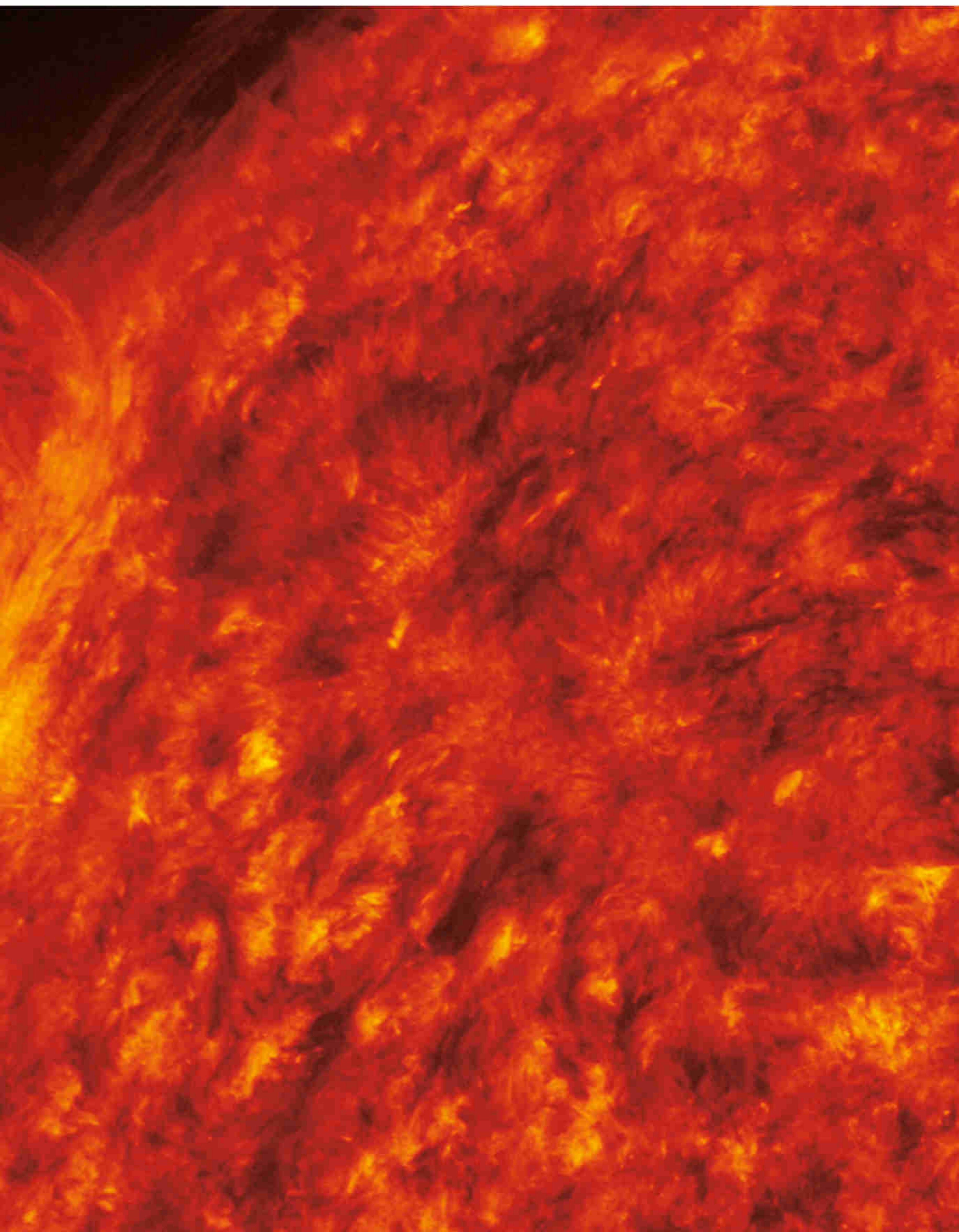
**The Sun** NASA's new Solar Dynamics Laboratory reveals an erupting plasma plume—aka a solar prominence—looping into the atmosphere along a magnetic field line. Ten Earths could be stacked inside the twisting ring.

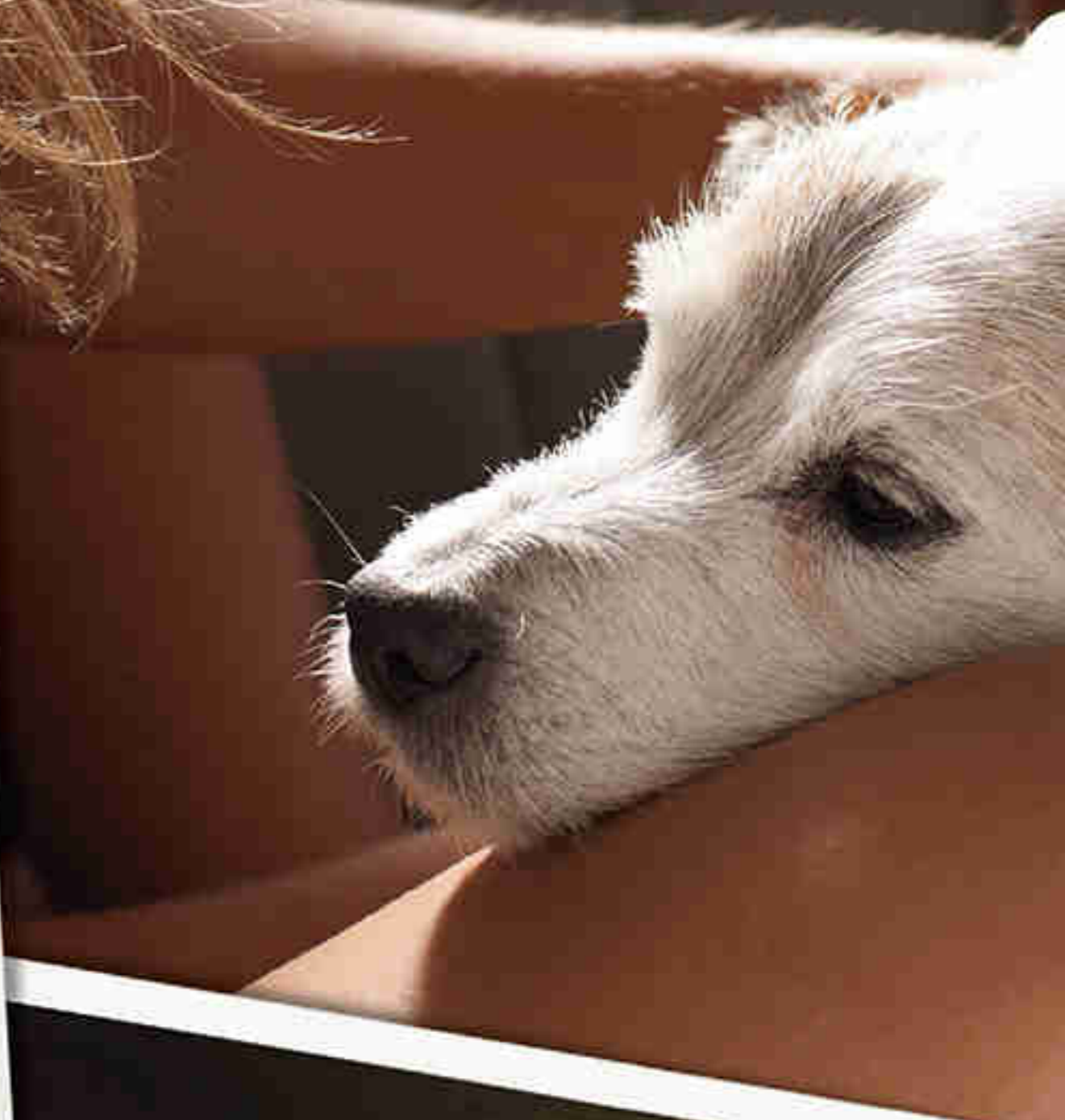




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IMAGE: NASA





## I LOVE THAT NEW ME SMELL

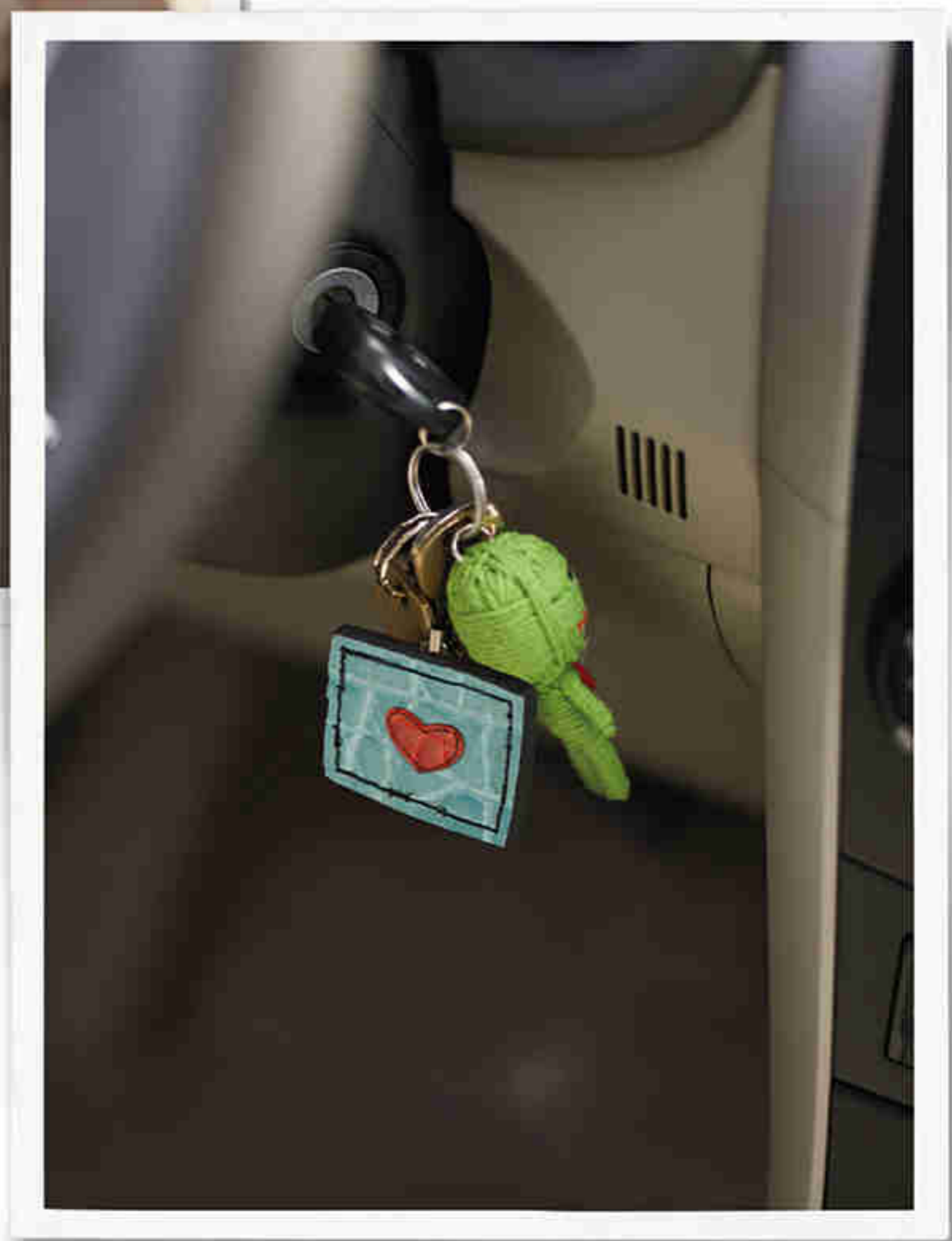
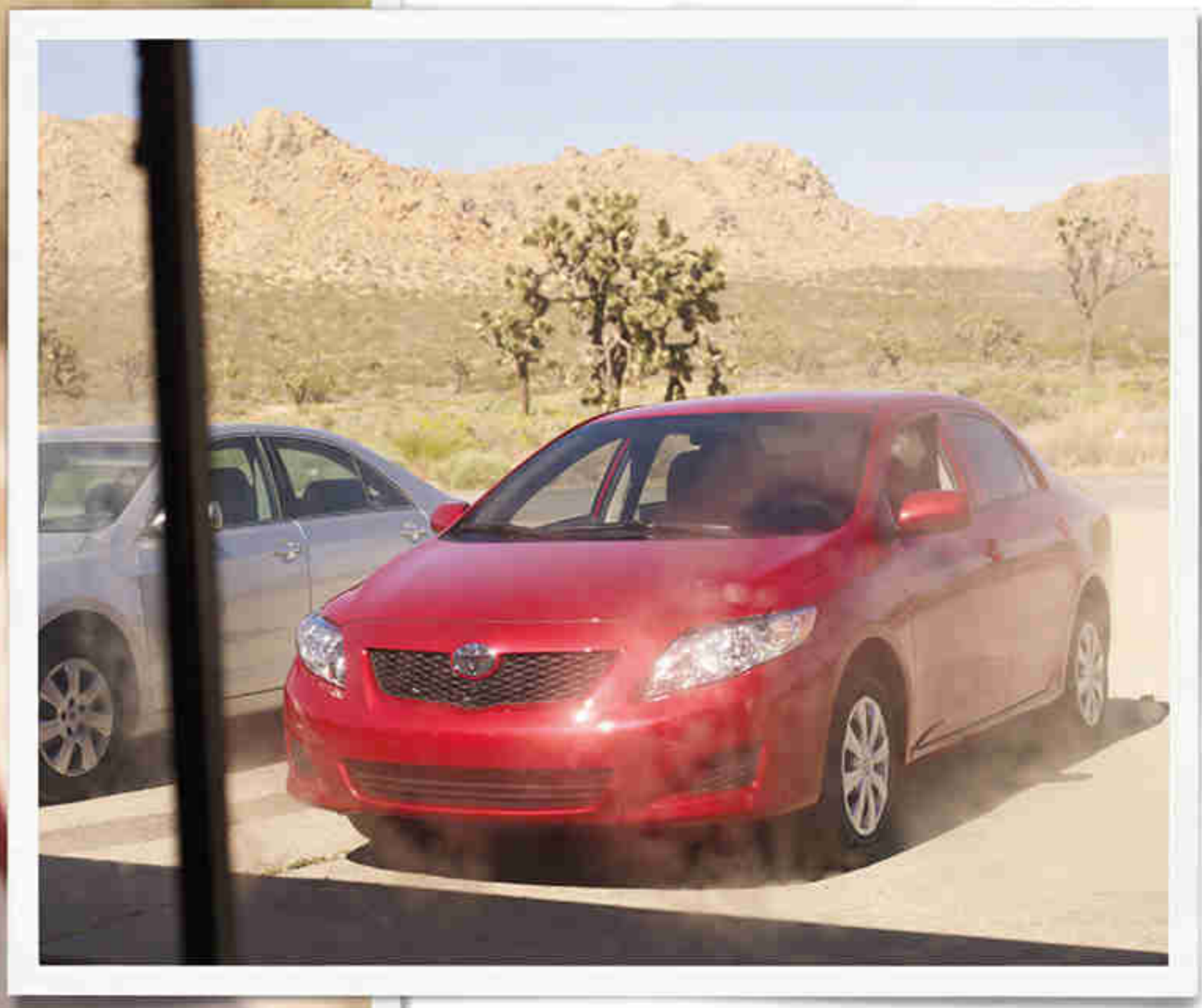
I had been in New York for eight years.  
I needed a change of pace.

At twenty-six I kind of woke up and was like, "All right, time to go." A couple of months later, I drove out to California with my dad. I had to have a car to get around LA, so I got a new Corolla. It's my first brand new car that I bought on my own. It was like, I don't know, I made it. Like, I'm an adult.

Stephanie Powell  
2010 Corolla owner

Every Toyota has a story. And with 35 million Corollas sold worldwide\*, we want to hear yours.  
Share it at [facebook.com/toyota](https://facebook.com/toyota)

Thanks for your story, Stephanie!



 **TOYOTA**  
moving forward

Options shown.\*Based on Toyota Motor Corporation sales data since Corolla's inception in 1966 through January 2009. ©2010 Toyota Motor Sales, U.S.A., Inc.

A Sherpa on Mount Everest sorts trash into plastics, metals, and biodegradables.



## Left on Everest

For 60 years climbers have dumped gear and trash en route to the top of Mount Everest, often in the low-oxygen “death zone” above 26,000 feet, where shedding a few pounds can preserve precious energy.

In recent years melting ice has begun to reveal the scope of the high-altitude imprint, exposing oxygen tanks and other long-frozen jetsam. Though tons of refuse are removed annually from base camps, last spring two Nepali groups, Extreme Everest Expedition and Eco Everest Expedition, targeted the peak’s upper reaches and hauled down seven tons of waste, including debris from a 1973 helicopter crash.

Nepalis are also concerned about corpses collecting on the mountain they consider holy. Since 1996 some 80 climbers have perished above base camp; most remain near the spot they died. In May two bodies, a Swiss and a Russian, were removed along with a pair of unidentified arms, one wearing a watch. Bringing back corpses was long considered logistically unfeasible, says Linda McMillan of the International Mountaineering and Climbing Federation. But as traffic on Everest has risen, she notes, so too has the desire to clean it. —Peter Gwin



Melting ice exposed an unidentified arm (hand above) and a watch (top right).

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*Enric Sala, National Geographic Ocean Fellow, Marine Biologist*

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## African Gem Cutter Makes \$2,689,000 Mistake... Will You?

This story breaks my heart every time. Allegedly, just two years after the discovery of tanzanite in 1967, a Maasai tribesman knocked on the door of a gem cutter's office in Nairobi. The Maasai had brought along an enormous chunk of tanzanite and he was looking to sell. His asking price? Fifty dollars. But the gem cutter was suspicious and assumed that a stone so large could only be glass. The cutter told the tribesman, no thanks, and sent him on his way. Huge mistake. It turns out that the gem was genuine and would have easily dwarfed the world's largest cut tanzanite at the time. Based on common pricing, that "chunk" could have been worth close to \$3,000,000!

The tanzanite gem cutter missed his chance to hit the jeweler's jackpot...and make history. Would you have made the same mistake then? Will you make it today?

**In the decades since its discovery, tanzanite has become one of the world's most coveted gemstones.**

Found in only one remote place on Earth (in Tanzania's Merelani Hills, in the shadow of Mount Kilimanjaro), the precious purple stone is 1,000 times rarer than diamonds. Luxury retailers have been quick to sound the alarm, warning that supplies of tanzanite will not last forever. And in this case, they're right. Once the last purple gem is pulled from the Earth, that's it. No more tanzanite. Most believe that we only have a few years supply left, which is why it's so amazing for us to offer this incredible price break. Some retailers along Fifth Avenue are more than happy to charge you outrageous prices for this rarity. Not Stauer. Staying true to our contrarian nature, we've decided to *lower the price of one of the world's rarest and most popular gemstones.*

Our 2-Carat *Sunburst Tanzanite Ring* features marquise-cut gems set dramatically in gorgeous sterling silver. Each facet sparkles with the distinct violet-blue hue of the precious stones. Behind the shine you'll find that the exquisite silverwork of the setting calls to mind the detailed treasures being produced by Europe's finest jewelers. This is a ring designed to impress and it does not disappoint.

Now is the point where opportunity knocks. If you open that door today, you can own this spectacular ring for less than \$100. If you wait? We can't say for sure.

**Your satisfaction is completely guaranteed.** For our client-friendly approach, Stauer has earned a rare **A+ rating from the Better Business Bureau**, a rating we wish to keep. So, of course, your satisfaction is 100% guaranteed. If you are not completely aglow with the *Sunburst Tanzanite Ring*, send it back within 30 days for a prompt and courteous refund. But, please don't wait, our supply is dropping rapidly.

**JEWELRY SPECS:**

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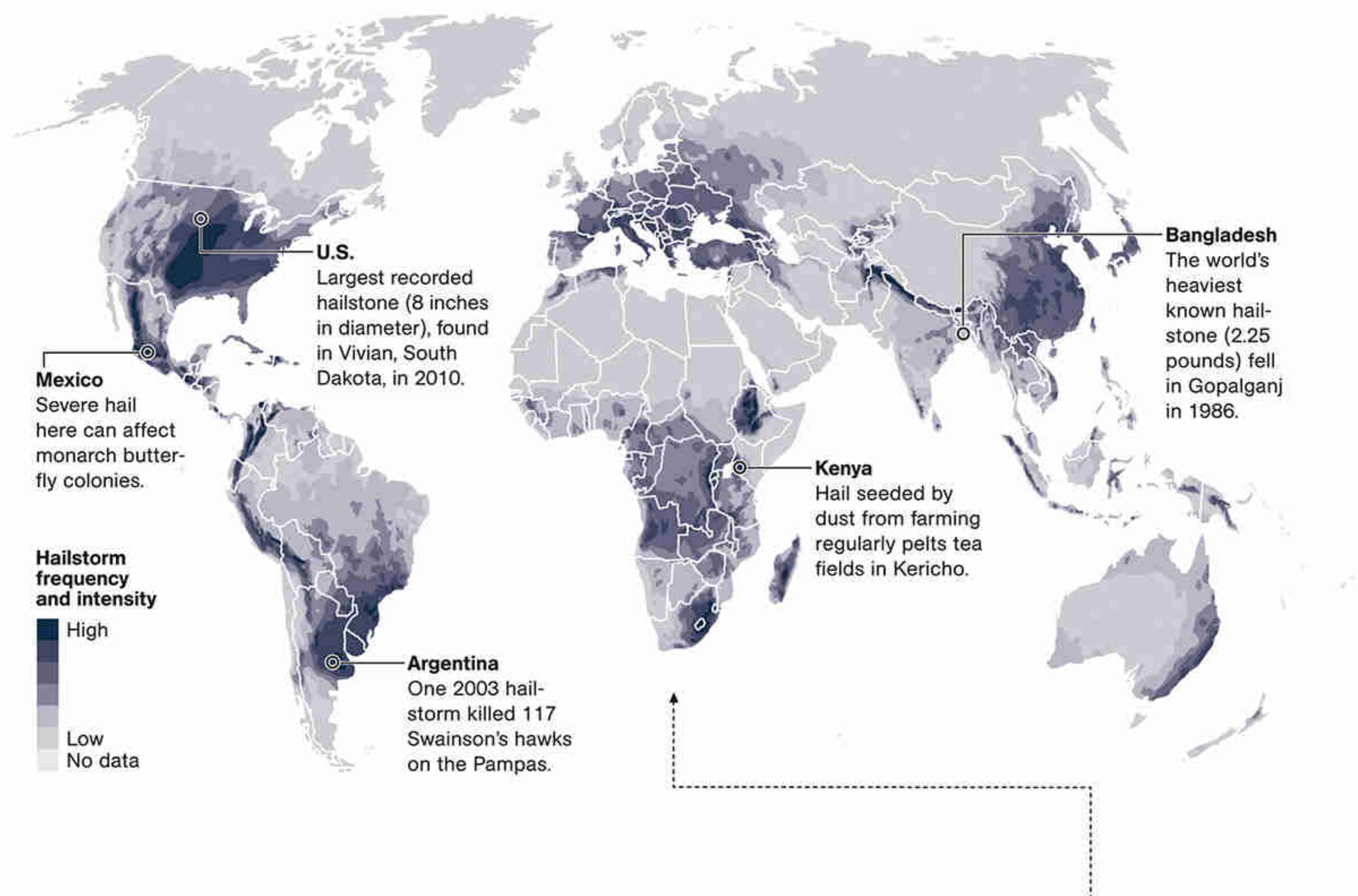
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## Where's the Hail?

The United States has had some of the largest hailstones, but Kericho, Kenya, may hold the record for most frequent hail.



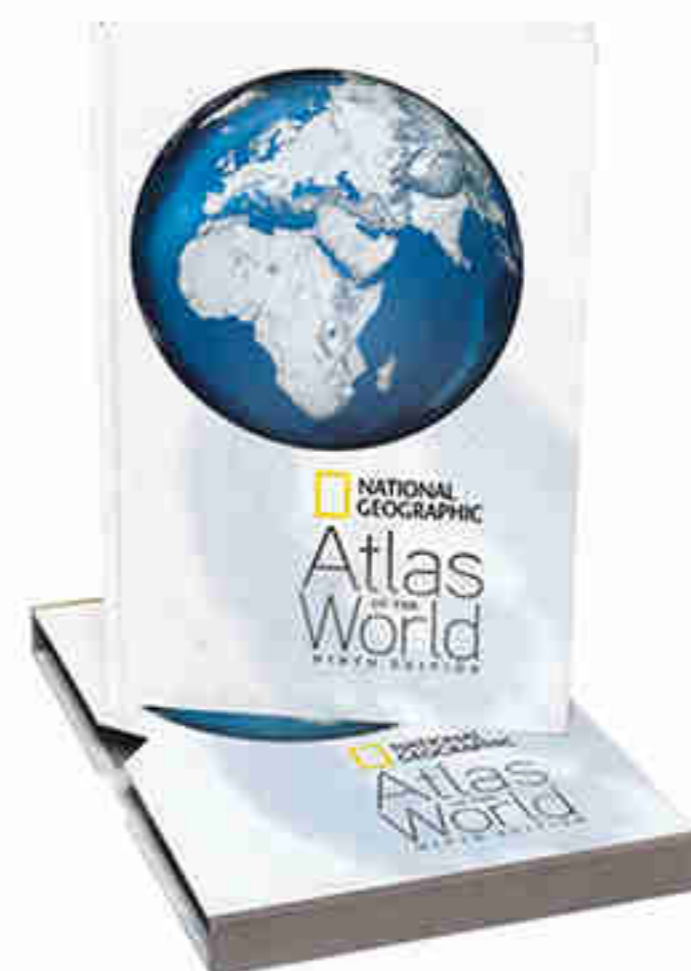
**It's not easy to make a hailstone**—conditions have to be just right. First come cumulonimbus clouds. What's needed next are powerful updrafts and downdrafts. These winds carry forming precipitation up to the frigid top of the clouds to freeze solid and then down toward the warmer bottom again to collect more moisture, before repeating the cycle. The more times the cycle repeats, the bigger the hailstones can grow (this baseball-size hailstone, left, fell in Kansas in May 2007)—and the more severe the damage down below.



Most hail hits in the midlatitudes, on plains downwind of major mountain chains. But intense hail conditions can exist wherever warm, moist air is pushed to great heights, even near the Equator.

The high-altitude tea-growing region of Kericho, Kenya, is more than 7,000 feet above sea level and may have more days with hail than any other place in the world.

In 2009, 306 destructive hailstorms in 16 states caused more than \$500 million in damage to crops and property in the United States. With warmer, wetter summers predicted for the Great Plains, experts fear that number is sure to rise. —Thomas Hayden



### New Atlas

This map is from the ninth edition of the *Atlas of the World*, the most comprehensive and largest format atlas ever published by National Geographic, available this month. Learn more at [nationalgeographic.com/atlas](http://nationalgeographic.com/atlas).





"As the master craftsman who opened the famous Lincoln Pocket Watch in Washington, D.C., I recently reviewed the Stauer Meisterzeit timepiece. The assembly and the precision of the mechanical movement are the best in its class."

—George Thomas  
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View the precision movement of the *Meisterzeit* through the rear exhibition port.

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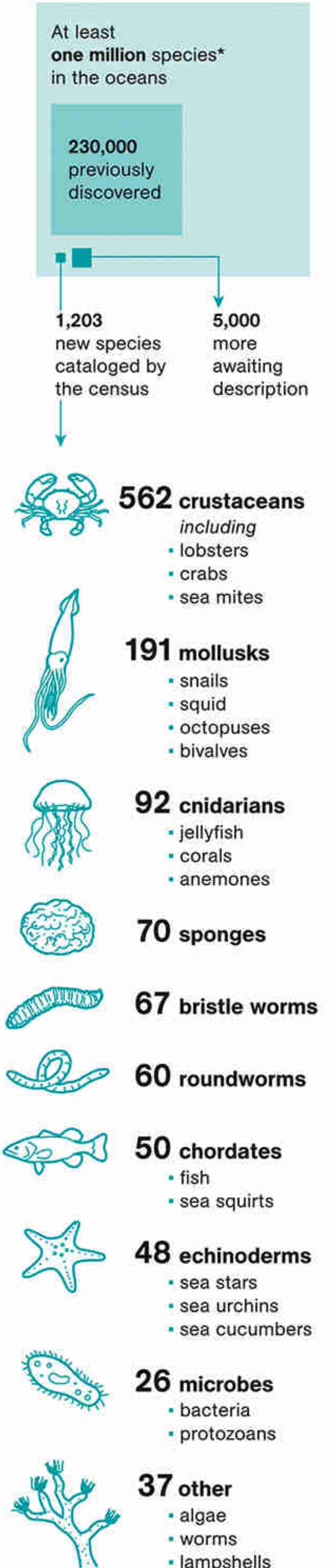
**One Fish Two Fish** Dr. Seuss had the right idea but the wrong tools. To begin a tally of all sea life, he'd have had to swap rhymes for research—say, 538 expeditions and 30 million records cataloged over ten years by 2,700 scientists from more than 80 nations.

That's what went into the landmark Census of Marine Life, which unveils its full findings this month. Conceived by scientists Frederick Grassle and Jesse Ausubel, the \$650-million survey—whose biggest funder was the Alfred P. Sloan Foundation—used everything from cutting-edge technologies to centuries-old fishing logs to find and ID species, map ecosystems, and assess data down to 16,000 feet.

"It's an astonishing start," says National Geographic Explorer-in-Residence Sylvia Earle. Yet with 95 percent of the ocean depths still unexplored, she says, a second census is warranted. "Don't we want to know who shares the planet with us?" —Jeremy Berlin

## OCEAN CENSUS

These figures hint at the scope of the seminal Census of Marine Life.



\*EXCLUDING MOST MICROBES; NEW SPECIES AS OF JULY 2010  
PHOTO: A. FIFIS, IFREMER 2006. ART: JASON LEE



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The status quo finds no refuge in the coils of Saab DNA. Proof is the all-new 9-5. Ice-blocked inspiration frames the sculpted taillights, and an airborne history drives all four wheels. Blacked-out A-pillars form the cockpit wraparound. Scandinavian landscape meets turbo IQ.

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**SAAB**  
move your mind™

Hydration experts are ready to rewrite the popular dictum that people should drink eight glasses of water a day.



## Shattering the Water Myth

Magazines, websites, even some medical texts recommend guzzling eight 8-ounce glasses of water a day. The bottled-water business loves it. Hydration experts, however, aren't sure where the "8 x 8" rule came from—or whether it holds water.

Mike Sawka, a U.S. Army research scientist, thinks the origins lie in a 1933 study on rodent hydration. The research led to a recommendation of 2.5 liters a day, or 84.5 ounces of liquid, for a moderately active human to make up for water lost to sweat and excretions. Twenty percent typically comes from foods high in water—soup,

ice cream, celery—leaving 67.6 ounces, or roughly "8 x 8." (Exercise or heat adds to a body's needs.)

Only you don't need eight daily glasses of water. Other beverages count, even if caffeinated. "The body's need to keep fluid trumps the small influence caffeine might have on losing fluid," says University of Connecticut exercise physiologist Douglas Casa. Plus the body isn't shy about liquid desires. Drink if you feel thirsty. If not, don't. One exception: Hydrate before an intense workout.

When in doubt, check your urine. Dark yellow, says University of Pennsylvania nutritionist Stella Volpe, is the hue of dehydration. —*Marc Silver*

# Is Diabetic Nerve Pain keeping you out of the game?



**LYRICA**<sup>®</sup>  
PREGABALIN <sup>Ⓒ</sup>  
capsules



**Diabetes damages nerves** which may cause a unique type of pain.\*

\*Artist depiction of diabetic nerve pain symptoms



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**Start the Lyrice conversation with your doctor today.**

**Prescription Lyrice is not for everyone.** Tell your doctor right away about any serious allergic reaction that causes swelling of the face, mouth, lips, gums, tongue, throat or neck or any trouble breathing or that affects your skin. Lyrice may cause suicidal thoughts or actions in a very small number of people. Call your doctor right away if you have new or worsening depression, suicidal thoughts or actions, or unusual changes in mood or behavior. Lyrice may cause swelling of your hands, legs and feet. Some of the most common side effects of Lyrice are dizziness and sleepiness. Do not drive or work with machines until you know how Lyrice affects you. Other common side effects are blurry vision, weight gain, trouble concentrating, dry mouth, and feeling "high." Also, tell your doctor right away about muscle pain along with feeling sick and feverish, or any changes in your eyesight including blurry vision or any skin sores if you have diabetes. You may have a higher chance of swelling, hives or gaining weight if you are also taking certain diabetes or high blood pressure medicines. Do not drink alcohol while taking Lyrice. You may have more dizziness and sleepiness if you take Lyrice with alcohol, narcotic pain medicines, or medicines for anxiety. If you have had a drug or alcohol problem, you may be more likely to misuse Lyrice. Tell your doctor if you are planning to father a child. Talk with your doctor before you stop taking Lyrice or any other prescription medication.

*Please see Important Facts Brief Summary on adjacent page.*

To learn more visit [www.lyrica.com](http://www.lyrica.com) or call toll-free 1-888-9-LYRICA (1-888-959-7422).

You are encouraged to report negative side effects of prescription drugs to the FDA.

Visit [www.FDA.gov/medwatch](http://www.FDA.gov/medwatch) or call 1-800-FDA-1088.

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# IMPORTANT FACTS



(LEER-i-kah)

## IMPORTANT SAFETY INFORMATION ABOUT LYRICA

LYRICA may cause serious, even life threatening, allergic reactions. Stop taking LYRICA and call your doctor right away if you have any signs of a serious allergic reaction:

- Swelling of your face, mouth, lips, gums, tongue, throat or neck
- Have any trouble breathing
- Rash, hives (raised bumps) or blisters

Like other antiepileptic drugs, LYRICA may cause suicidal thoughts or actions in a very small number of people, about 1 in 500.

Call your doctor right away if you have any symptoms, especially if they are new, worse or worry you, including:

- New or worsening depression
- Suicidal thoughts or actions
- Unusual changes in mood or behavior

Do not stop LYRICA without first talking with your doctor.

LYRICA may cause swelling of your hands, legs and feet.

This swelling can be a serious problem with people with heart problems.

LYRICA may cause dizziness or sleepiness.

Do not drive a car, work with machines, or do other dangerous things until you know how LYRICA affects you. Ask your doctor when it is okay to do these things.

## ABOUT LYRICA

LYRICA is a prescription medicine used in adults 18 years and older to treat:

- Pain from damaged nerves that happens with diabetes or that follows healing of shingles
- Partial seizures when taken together with other seizure medicines
- Fibromyalgia (pain all over your body)

Who should NOT take LYRICA:

- Anyone who is allergic to anything in LYRICA

## BEFORE STARTING LYRICA

Tell your doctor about all your medical conditions, including if you:

- Have had depression, mood problems or suicidal thoughts or behavior
- Have or had kidney problems or dialysis
- Have heart problems, including heart failure
- Have a bleeding problem or a low blood platelet count
- Have abused prescription medicines, street drugs or alcohol in the past
- Have ever had swelling of your face, mouth, tongue, lips, gums, neck, or throat (angioedema)
- Plan to father a child. It is not known if problems seen in animal studies can happen in humans.
- Are pregnant, plan to become pregnant or are breastfeeding. It is not known if LYRICA will harm your unborn baby.

You and your doctor should decide whether you should take LYRICA or breast-feed, but not both.

Tell your doctor about all your medicines. Include over-the-counter medicines, vitamins, and herbal supplements.

LYRICA and other medicines may affect each other causing side effects. Especially tell your doctor if you take:

- Angiotensin converting enzyme (ACE) inhibitors. You may have a higher chance for swelling and hives.

## BEFORE STARTING LYRICA, continued

- Avandia® (rosiglitazone)\*, Avandamet® (rosiglitazone and metformin)\* or Actos® (pioglitazone)\*\* for diabetes. You may have a higher chance of weight gain or swelling of your hands or feet.
- Narcotic pain medicines (such as oxycodone), tranquilizers or medicines for anxiety (such as lorazepam). You may have a higher chance for dizziness and sleepiness.
- Any medicines that make you sleepy

## POSSIBLE SIDE EFFECTS OF LYRICA

LYRICA may cause serious side effects, including:

- See "Important Safety Information About LYRICA."
- Muscle problems, pain, soreness or weakness along with feeling sick and fever
- Eyesight problems including blurry vision
- Weight gain. Weight gain may affect control of diabetes and can be serious for people with heart problems.
- Feeling "high"

If you have any of these symptoms, tell your doctor right away.

The most common side effects of LYRICA are:

- Dizziness
- Blurry vision
- Weight gain
- Sleepiness
- Trouble concentrating
- Swelling of hands and feet
- Dry mouth

If you have diabetes, you should pay extra attention to your skin while taking LYRICA and tell your doctor of any sores or skin problems.

## HOW TO TAKE LYRICA

Do:

- Take LYRICA exactly as your doctor tells you. Your doctor will tell you how much to take and when to take it. Take LYRICA at the same times each day.
- Take LYRICA with or without food.

Don't:

- Drive a car or use machines if you feel dizzy or sleepy while taking LYRICA.
- Drink alcohol or use other medicines that make you sleepy while taking LYRICA.
- Change the dose or stop LYRICA suddenly. You may have headaches, nausea, diarrhea, or trouble sleeping if you stop taking LYRICA suddenly.
- Start any new medicines without first talking to your doctor.

## NEED MORE INFORMATION?

- Ask your doctor or pharmacist. This is only a brief summary of important information.
- Go to [www.lyrica.com](http://www.lyrica.com) or call 1-866-459-7422 (1-866-4LYRICA).

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This section of Port-au-Prince's Boulevard Jean-Jacques Dessalines was reduced to rubble.

## Crisis Cartography

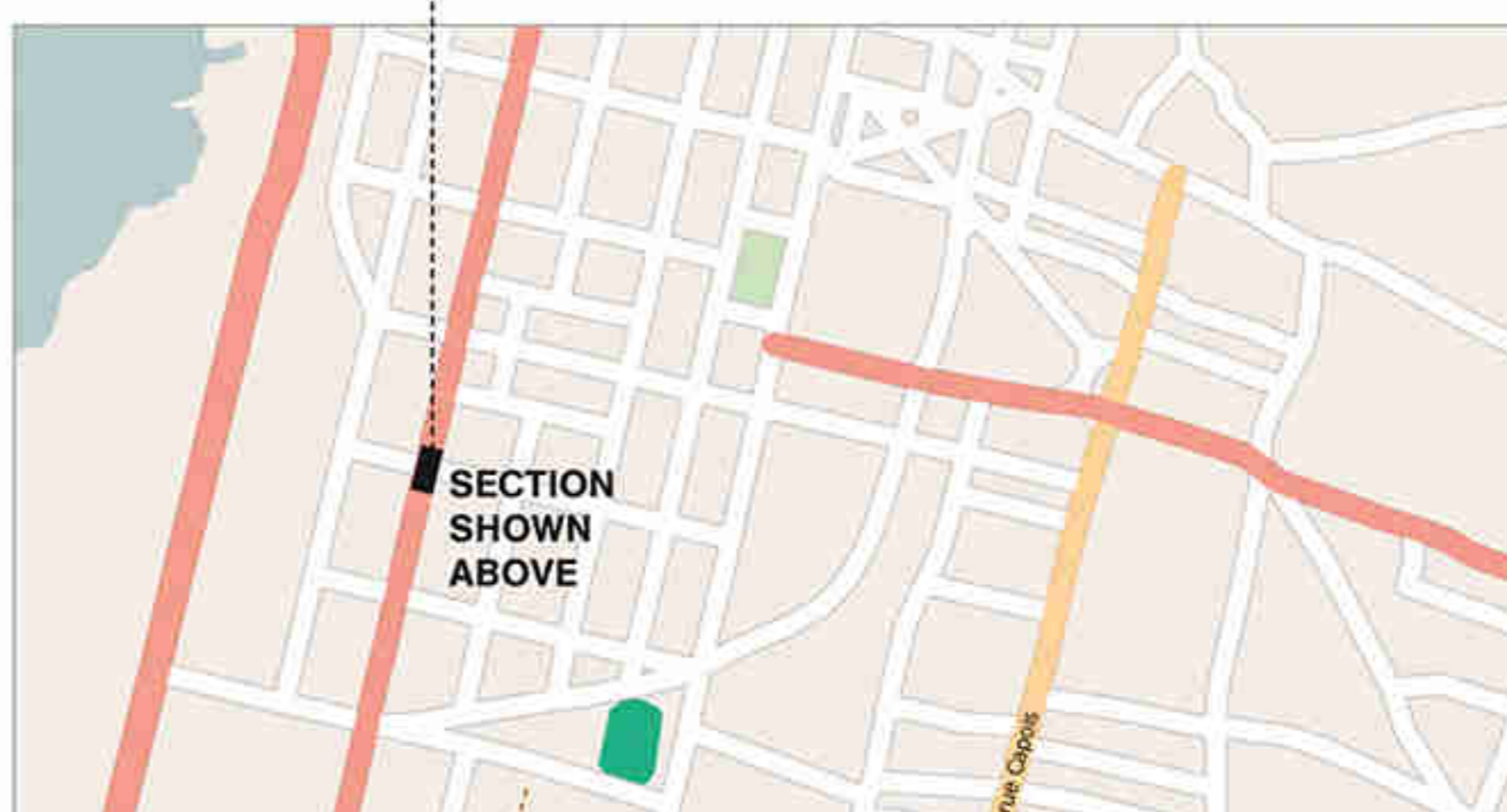
When disaster strikes, accurate maps can be lifesavers. After a magnitude 7 earthquake rocked Haiti on January 12, first responders were hampered by the scarcity of street maps—but not for long. Within hours, volunteers in the capital city,

Port-au-Prince, and elsewhere had filled in cartographic blanks, creating far more detailed, accessible, and immediate maps and images than

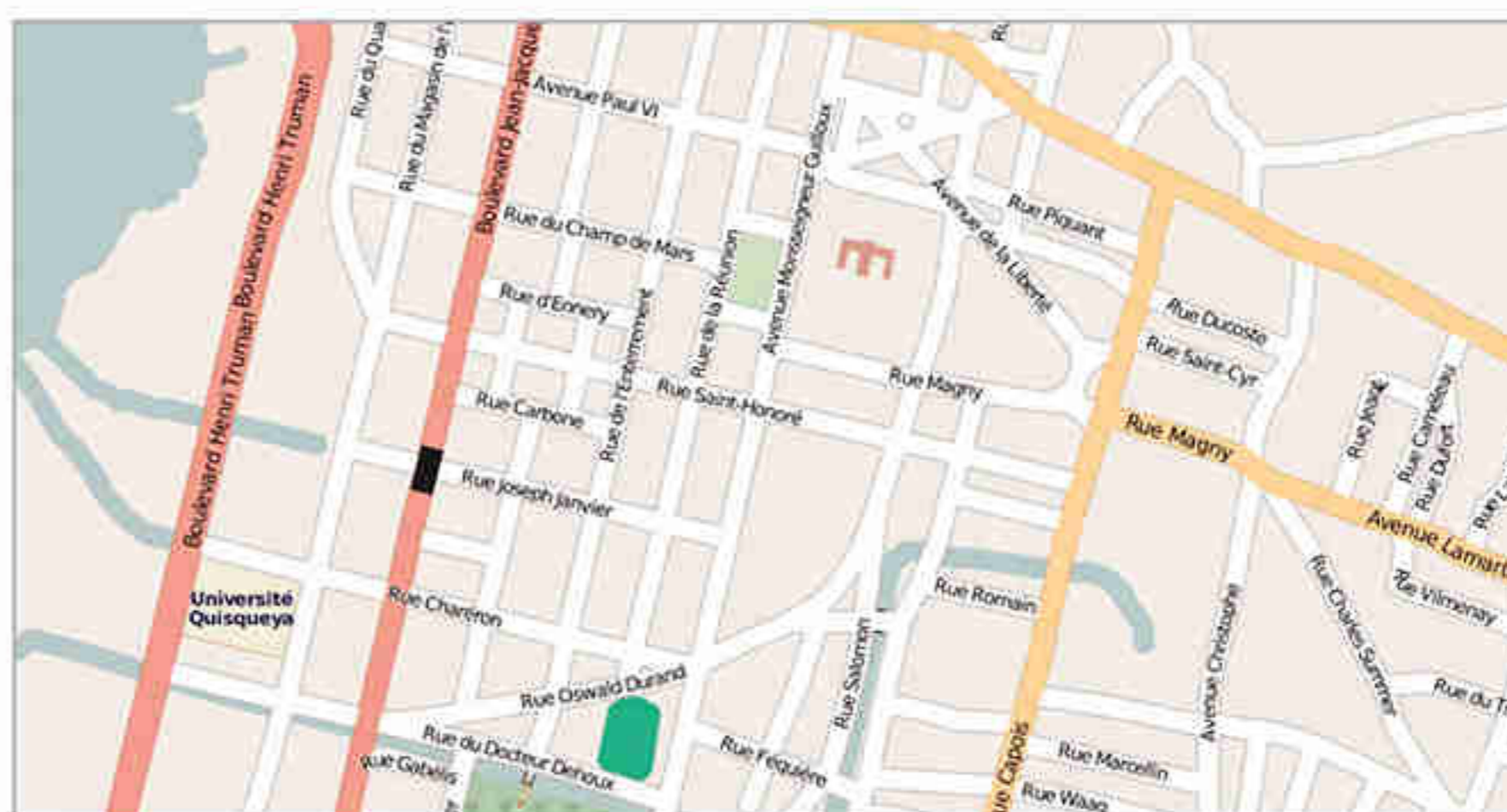
most of those available online.

Using text messages, GPS, and plain old pencils and paper, they dispatched thousands of alerts a day about street names, building collapses, and injury locations. Disaster-response nerve centers synthesized the information with satellite data, which helped guide emergency workers, including the U.S. Marine Corps and Red Cross.

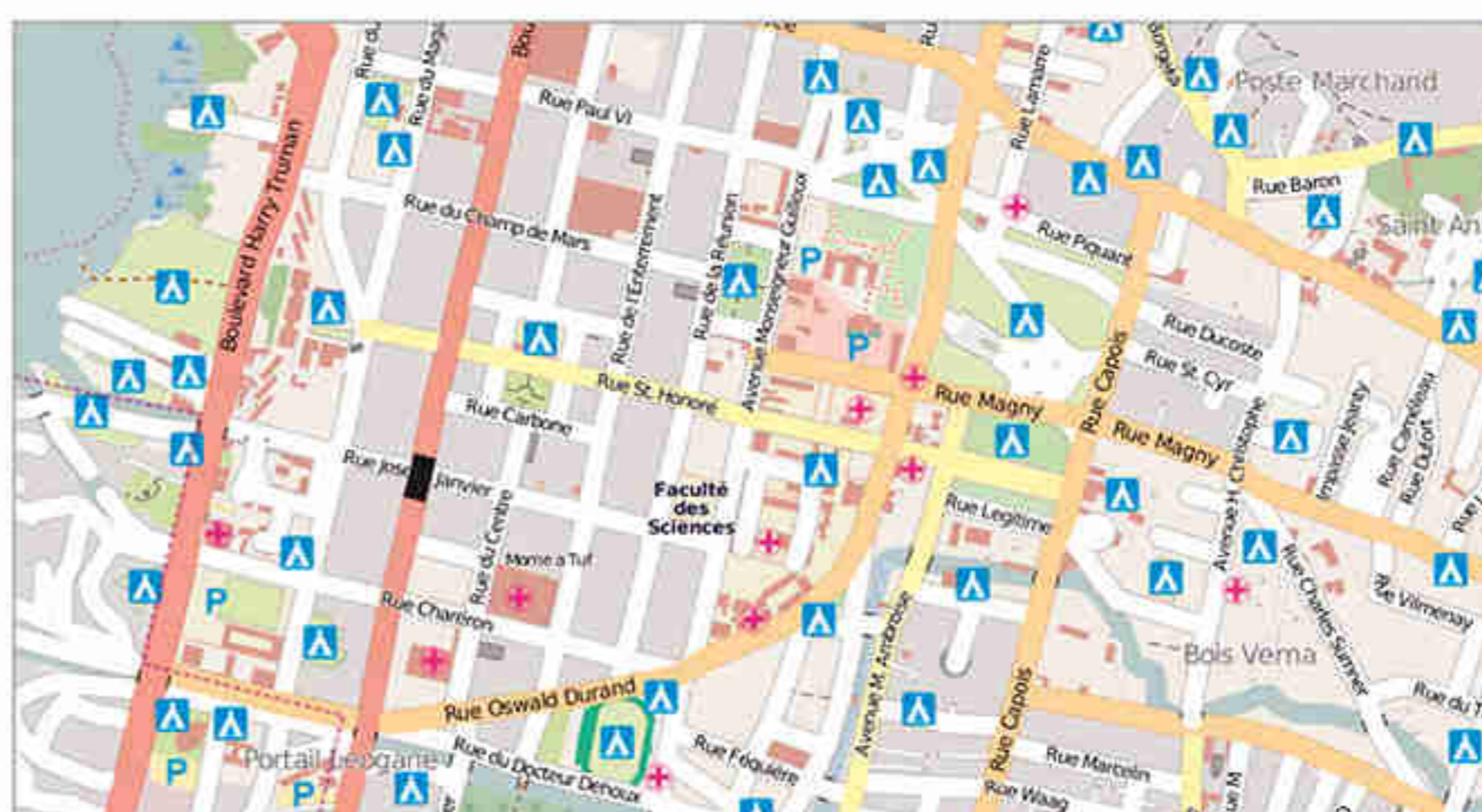
User-generated maps can present pitfalls. Accuracy, for instance, isn't guaranteed. But in Haiti benefits outweighed drawbacks. "Don't stop mapping," came a January 17 call from the Federal Emergency Management Agency to Ushahidi-Haiti, a student-run project at Tufts University. Crisis mappers won't. —Hannah Bloch



**DECEMBER 30, 2009** Two weeks before the quake, this user-generated map of Port-au-Prince included minimal information about streets and landmarks.



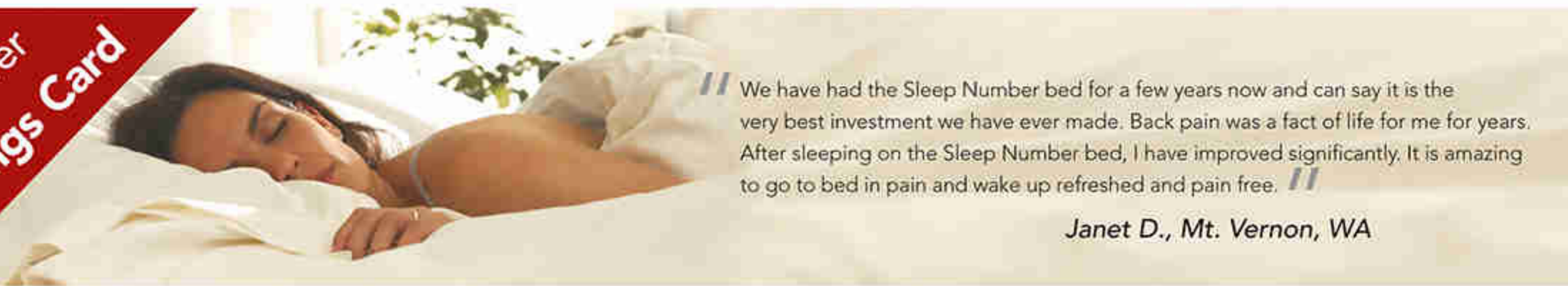
**JANUARY 13, 2010** OpenStreetMap elicited street names the day after.



**JANUARY 29, 2010** Clinic and shelter locations were soon pinpointed as well.



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Janet D., Mt. Vernon, WA

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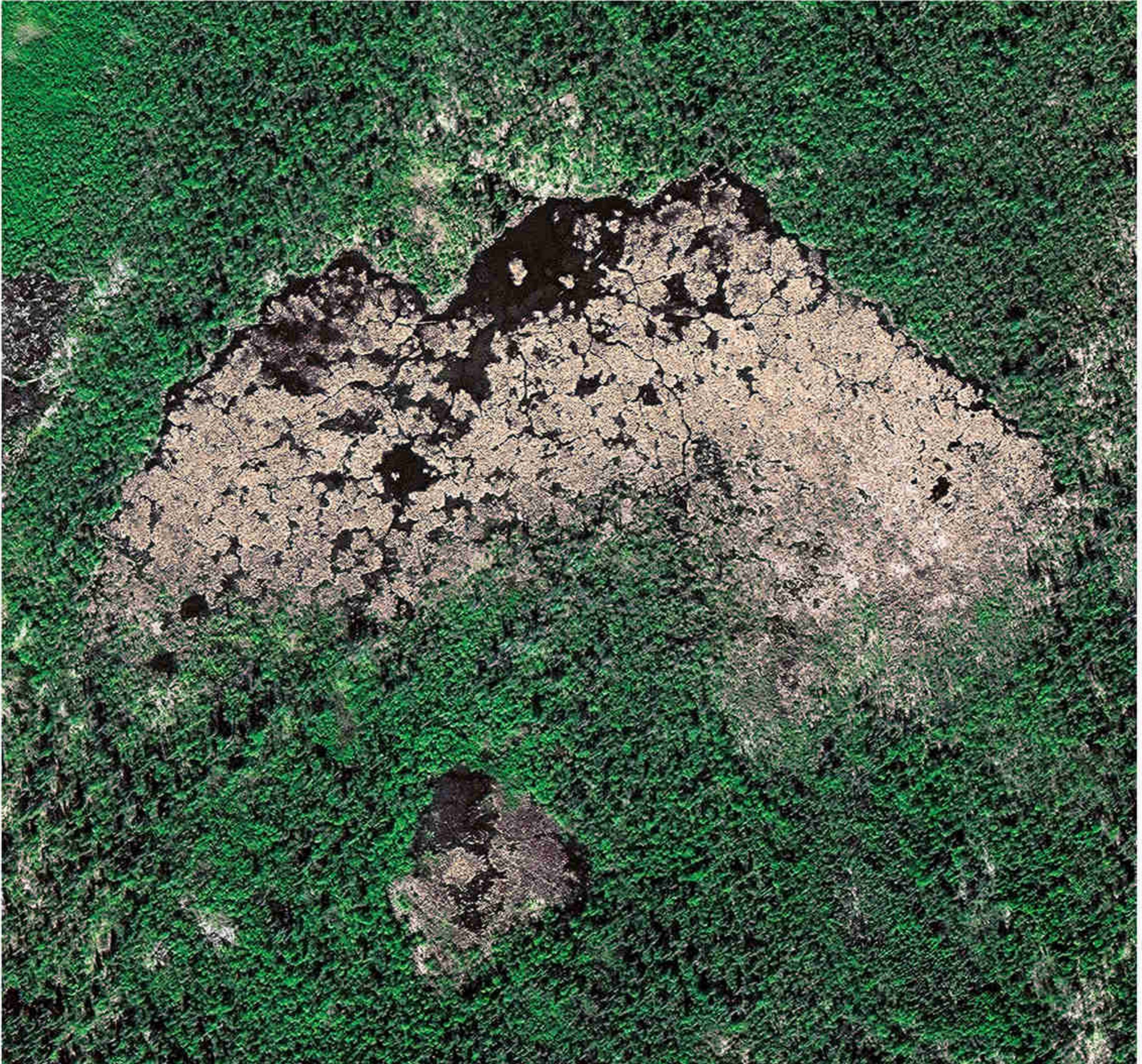
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\*Descriptions of clinical studies conducted on the Sleep Number bed are available at 1-800-831-1211.  
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## WHERE IN THE WORLD?



Visible from space, the world's largest known beaver dam stretches across nearly 3,000 feet of wetlands in northern Alberta, Canada.

**Home Improvement** Deep within Alberta, Canada's Wood Buffalo National Park, a massive engineering project is under way. The builders? Beavers. The job? Maintaining and expanding a dam likely begun by their ancestors decades ago. Today it's more than half a mile long—the largest beaver dam known to exist.

Landscape ecologist Jean Thie spotted the structure in October 2007 while using satellite technology to study melting permafrost. "This is the beaver belt," he explains, referring to the region's now dense population, which has rebounded from near extinction since the fur trade ended. Level, remote land also benefits these animals, letting them build without the nuisances and threats of fast-flowing water and humans. That means freedom to gather branches and mud for lodging and food storage, two keys to beaver prosperity.

So how many beavers does it take to build such a dam? No one can say. But the colony is clearly vast—and resourceful. Says wildlife biologist Clay Nielsen, "Beavers are second only to humans in modifying their living space to fit their needs." —*Catherine Barker*

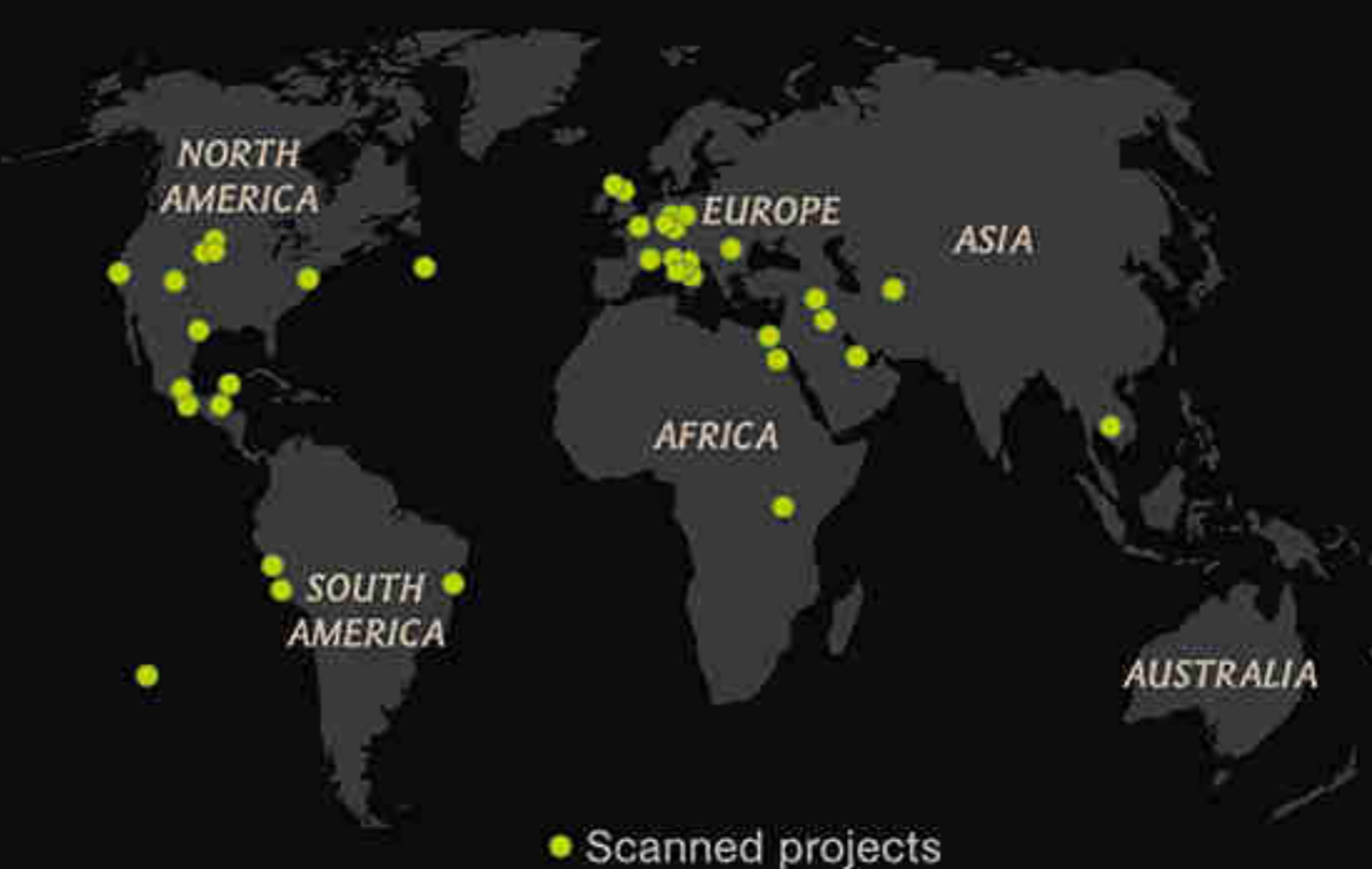


# Backing Up History

With portable 3-D laser scanners, preservationists are making digital records of the world's most vulnerable landmarks.

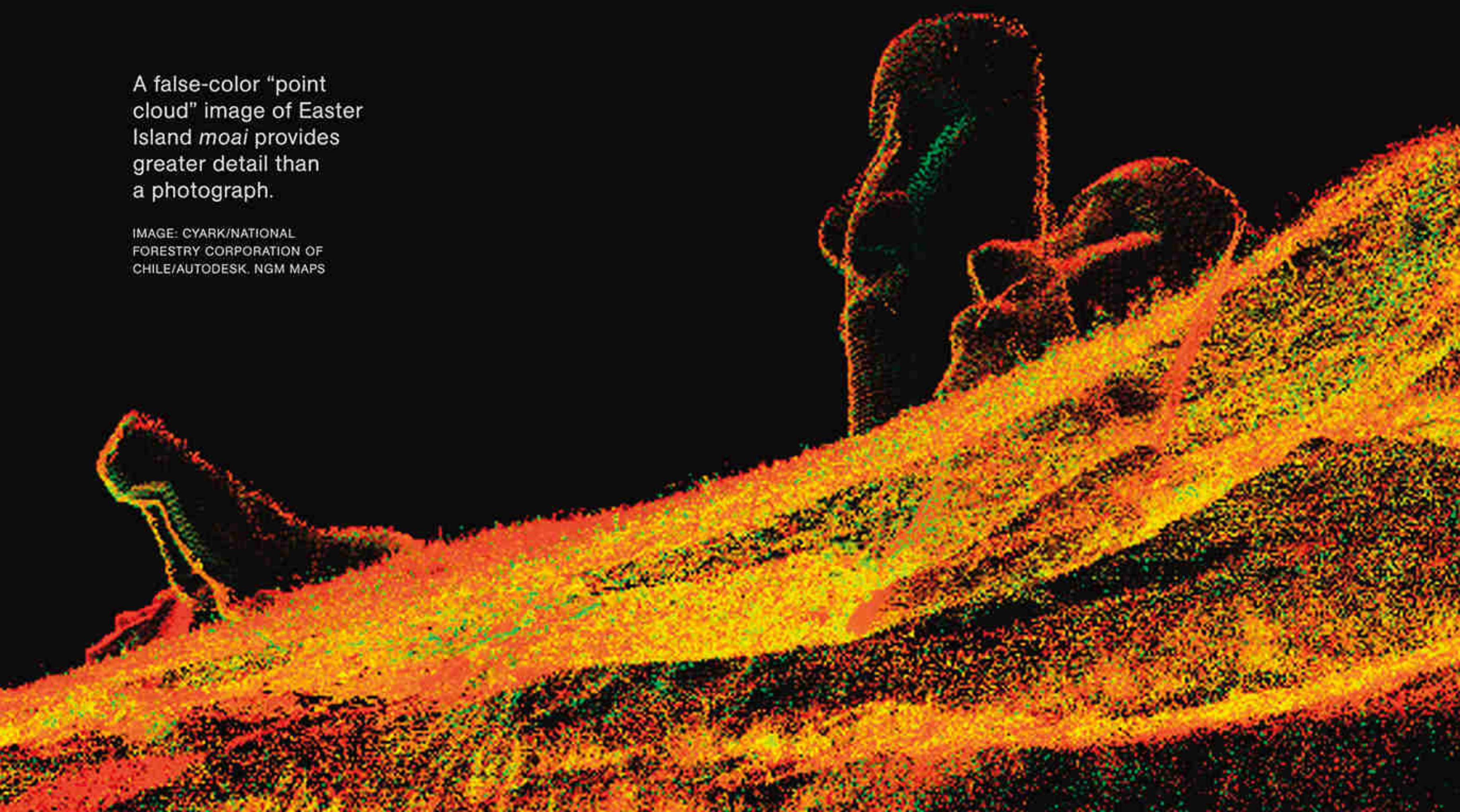
THE STONE GIANTS called *moai* have kept watch—and secrets—on Easter Island for centuries. Now preservationists have found a way to learn more about them. In 2007, six workers who'd partnered with the nonprofit CyArk arrived on the island with a 3-D laser scanner and other surveying equipment. They made high-resolution scans of carvings and caves, producing a data set so accurate they call it "reality capture."

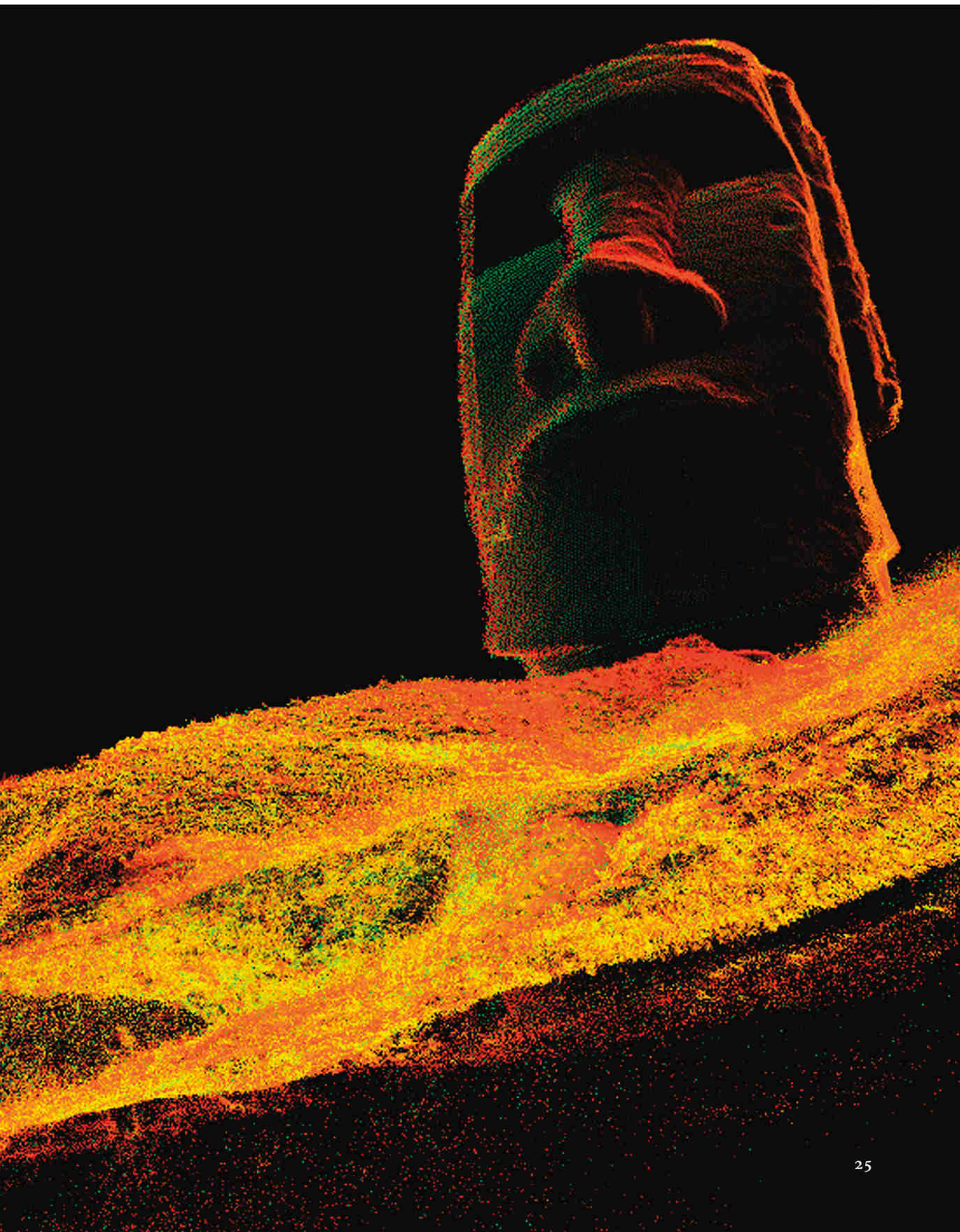
CyArk's mission is to collect detailed digital records of cultural heritage sites around the world (see map at right), from the *Titanic* wreck to Mexico's Teotihuacan. Its key tool is a portable 3-D laser scanner that sweeps an area with a pulsing laser and returns a high-definition map of the surrounding surfaces. With data recorded as close as every half centimeter, the resulting surface map shows a "point cloud" (Continued)



A false-color "point cloud" image of Easter Island *moai* provides greater detail than a photograph.

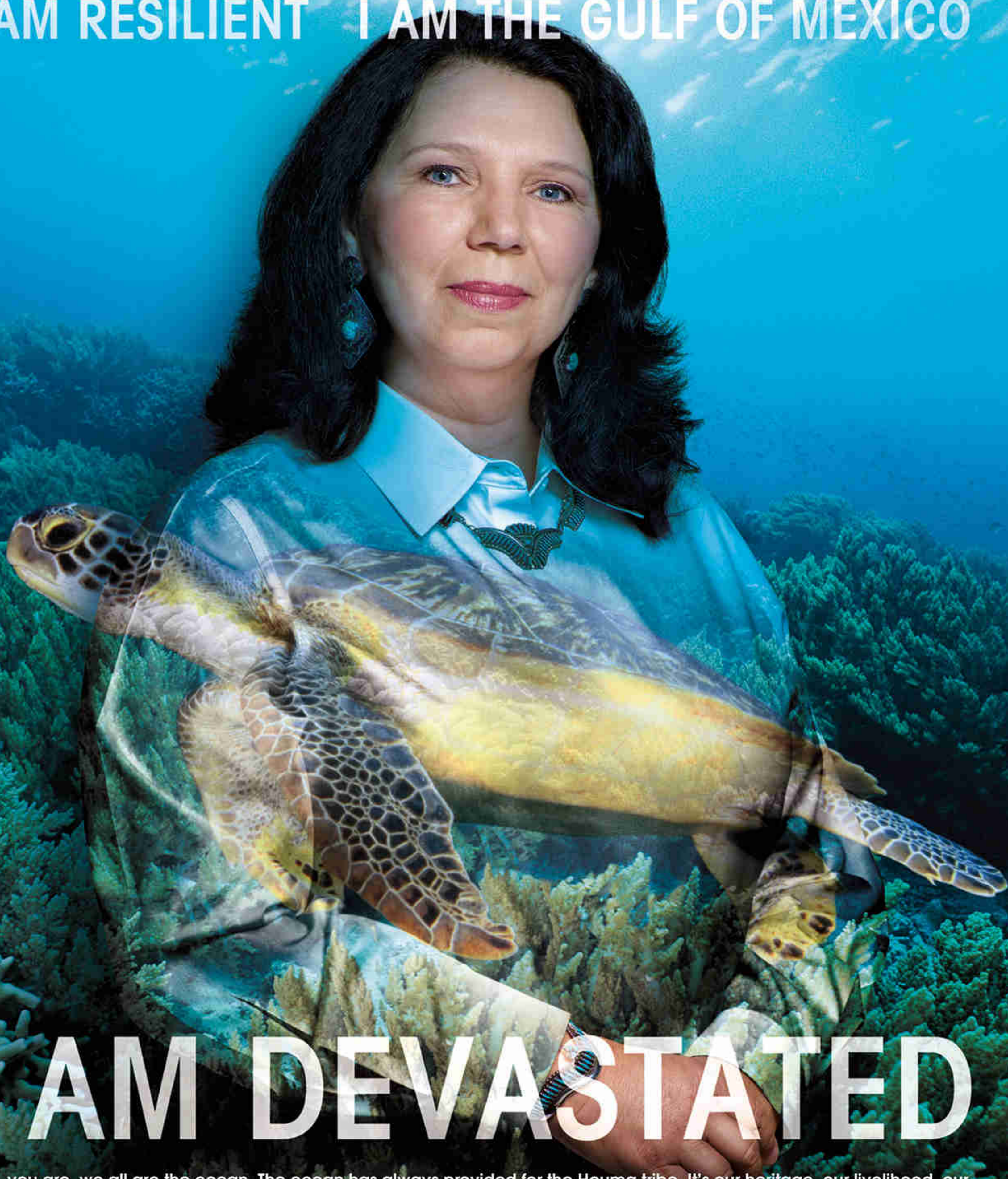
IMAGE: CYARK/NATIONAL FORESTRY CORPORATION OF CHILE/AUTODESK, NGM MAPS





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*Brenda Dardar Robichaux, Gulf Coast resident and Former Chief of the Houma tribe*

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- Have instant comfort
- Cool your feet & reduce foot odor
- Elevate your performance

I put them on and all I could say was, "WOW!" In minutes I was

out the door. I was invincible; tireless in my new Gravity Defyer shoes. It was as if my legs had been replaced with super-powered bionics. What the doctor promised was all correct. No more knee pain.

I started to lose weight. At last, I was pain free and filled with energy! I was back in the game. Gravity had no power over me!

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So, my friend, get back on your feet like I did.

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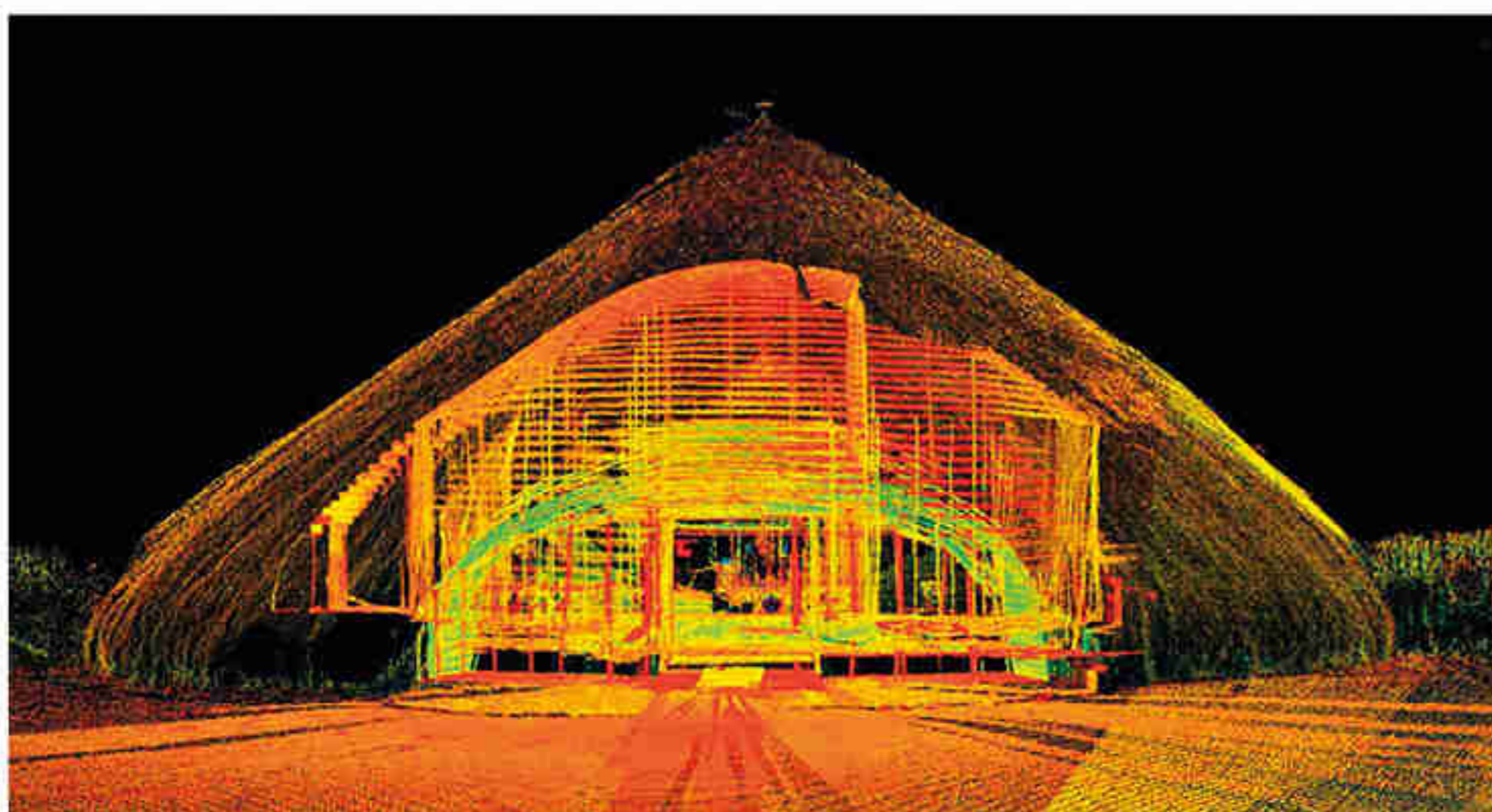




## THE BIG IDEA



**Built in 1882** Uganda's Kasubi tombs were declared a UNESCO World Heritage site in 2001. Four kings were buried in this thatched structure.



**Scanned in 2009** A CyArk laser scan created this point cloud image revealing details, including the building's high-ceilinged interior.



**Destroyed in 2010** Local people gathered as flames engulfed the tombs. The cause of the fire remains unknown.

that can include hundreds of millions of pieces of data. In addition to 3-D coordinates, the laser scanner records each point's "intensity return," a value that represents the color and brightness of the scanned object's surface. These values are shown with a false coloring (center image, left). Analysts can use this information to see where cracks are developing or whether newer materials have been incorporated into a structure.

Ben Kacyra was one of the inventors of the laser scanner used in the surveys and is also CyArk's founder. He was inspired to start the nonprofit after the Taliban demolished Afghanistan's Bamiyan Buddhas in 2001. If detailed laser scans are available, he reasoned, at least something remains in the event of a site's loss.

Such a loss occurred earlier this year, when fire consumed the royal Kasubi tombs in Uganda. Four kings of Buganda—a kingdom within the country—were entombed in the wood-and-thatch structure. A year earlier, though, CyArk had collected scans there. Within days of the fire, a Buganda prince was talking to CyArk about rebuilding.

CyArk has identified more than 800 at-risk sites to survey. Where resources allow, it works with an international network of partners to scan the sites—38 so far. All data collected is archived and publicly available at [cyark.org](http://cyark.org).

"Our collective memory is in the works of man," Kacyra says. "This is really not just a matter of preserving this site or that site. It's a matter of preserving our human collective memory." —Elizabeth Preston

An aerial photograph of two oil tankers on the open sea. The sky is filled with dark, heavy clouds, with a bright light source breaking through on the left side. The water is dark blue with visible ripples. The tankers are positioned in the lower half of the frame, one slightly ahead of the other.

# THE GULF OF OIL

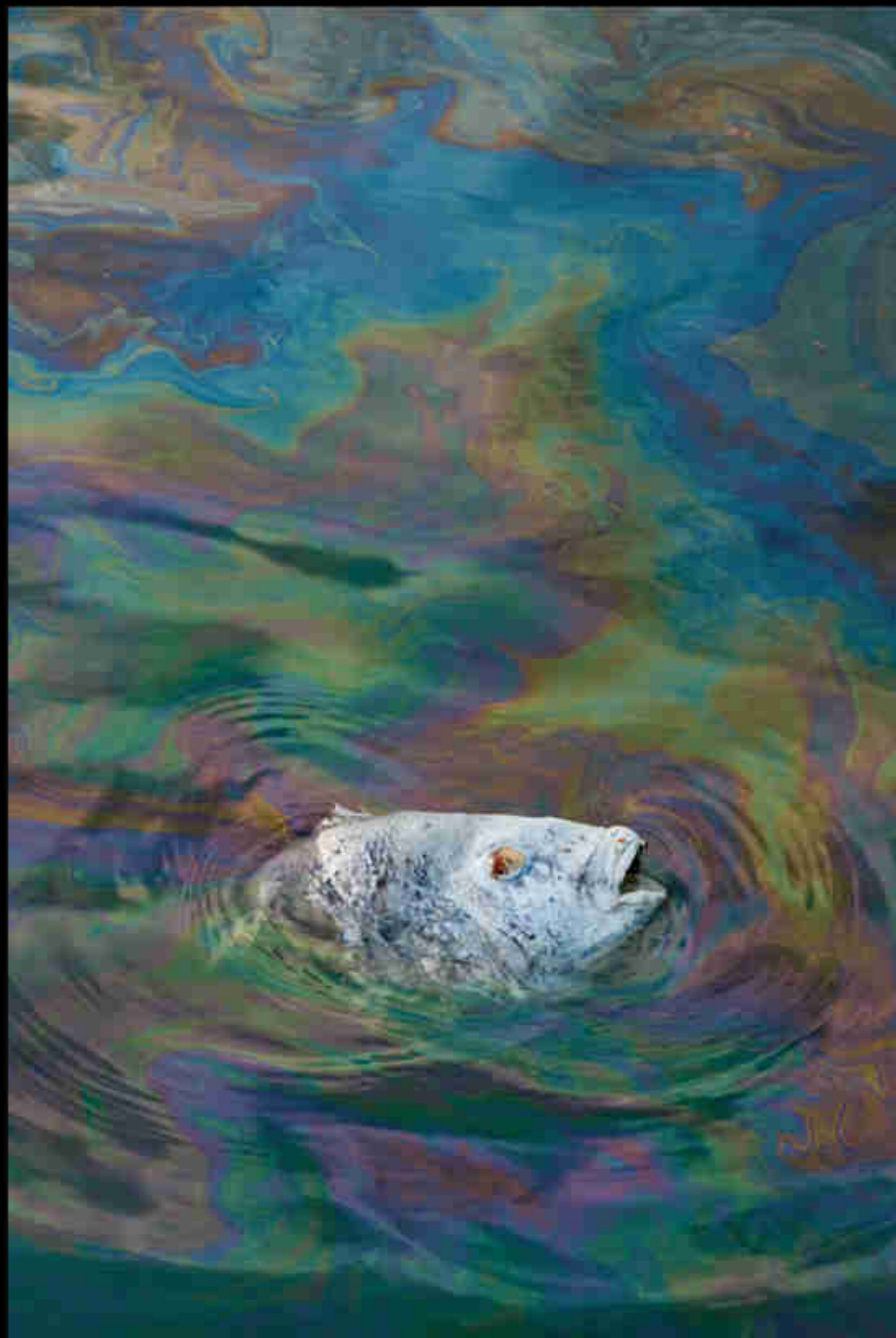


*Smoke rises from surface oil being burned by cleanup crews near the Deepwater Horizon blowout. The well spewed nearly five million barrels, making it the world's largest accidental marine oil spill.*

JOEL SARTORE

UNFLAGGING DEMAND  
FOR OIL PROPELLED THE  
INDUSTRY INTO DEEP WATER.  
BUT THE BLOWOUT IN THE  
GULF FORCES THE QUESTION:


IS IT WORTH THE RISK?



*"You could see the life draining out of it," says parish official P. J. Hahn, who impulsively rescued this severely oiled brown pelican on Queen Bess Island, La. The bird lived.*

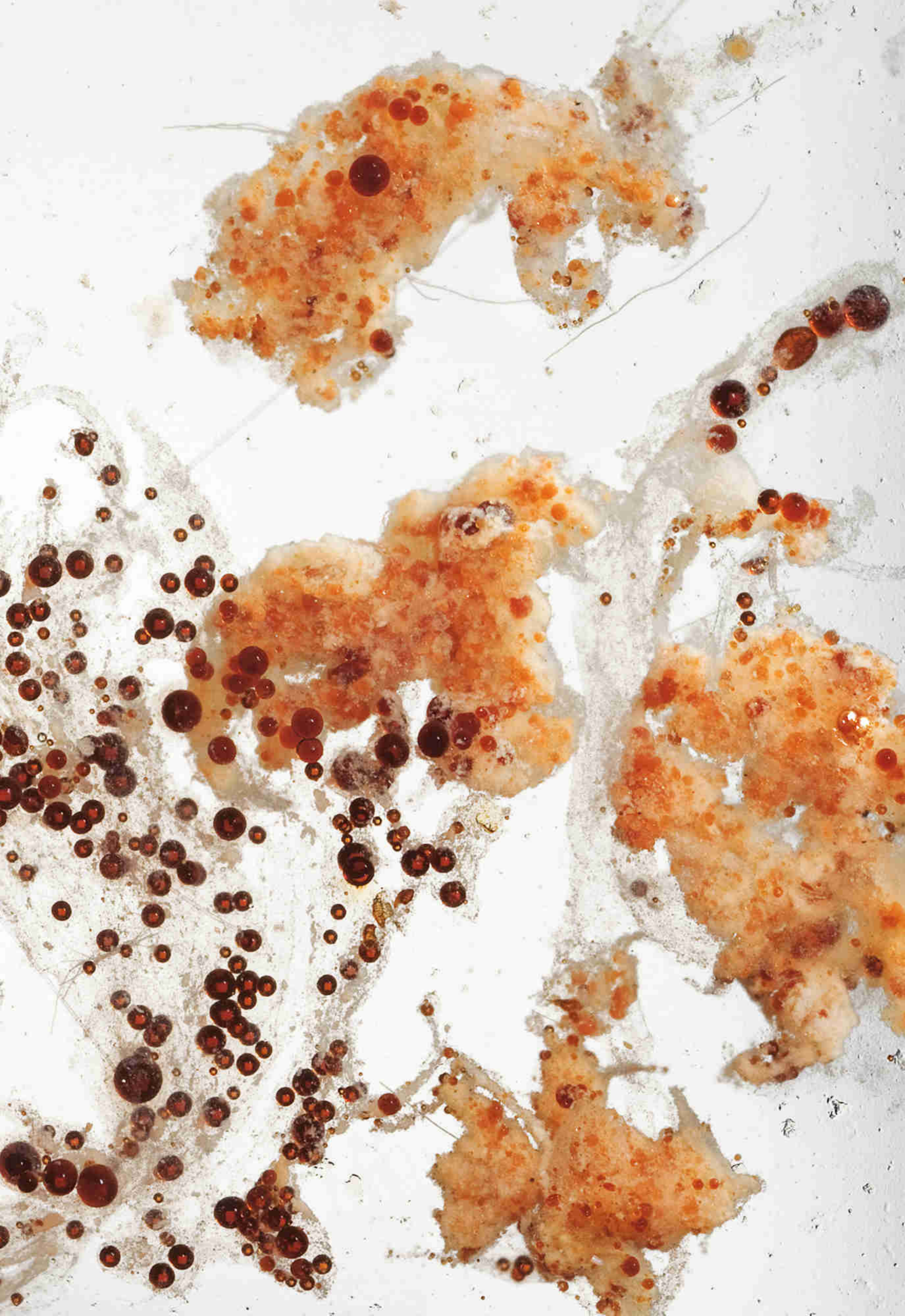
JOEL SARTORE (BOTH)



A detailed photograph of a shrimp, likely a species of penaeid, heavily contaminated with dark brown, viscous oil. The shrimp is oriented vertically, with its head at the bottom and tail at the top. Its body is covered in a thick, irregular coating of oil, which has also spread to the surrounding environment, creating large, textured patches of brown and orange. Numerous small, dark brown globules of oil are scattered throughout the scene, some appearing to be attached to the shrimp's legs and antennae. The background is a light, off-white color, providing a stark contrast to the dark, oily substance.

*A shrimp the size of a staple swims amid dark brown globules of oil. The effect of the spill on the eggs and larvae of shrimps, crabs, and fish, all key to the local economy, remains unknown.*

DAVID LIITTSCHWAGER



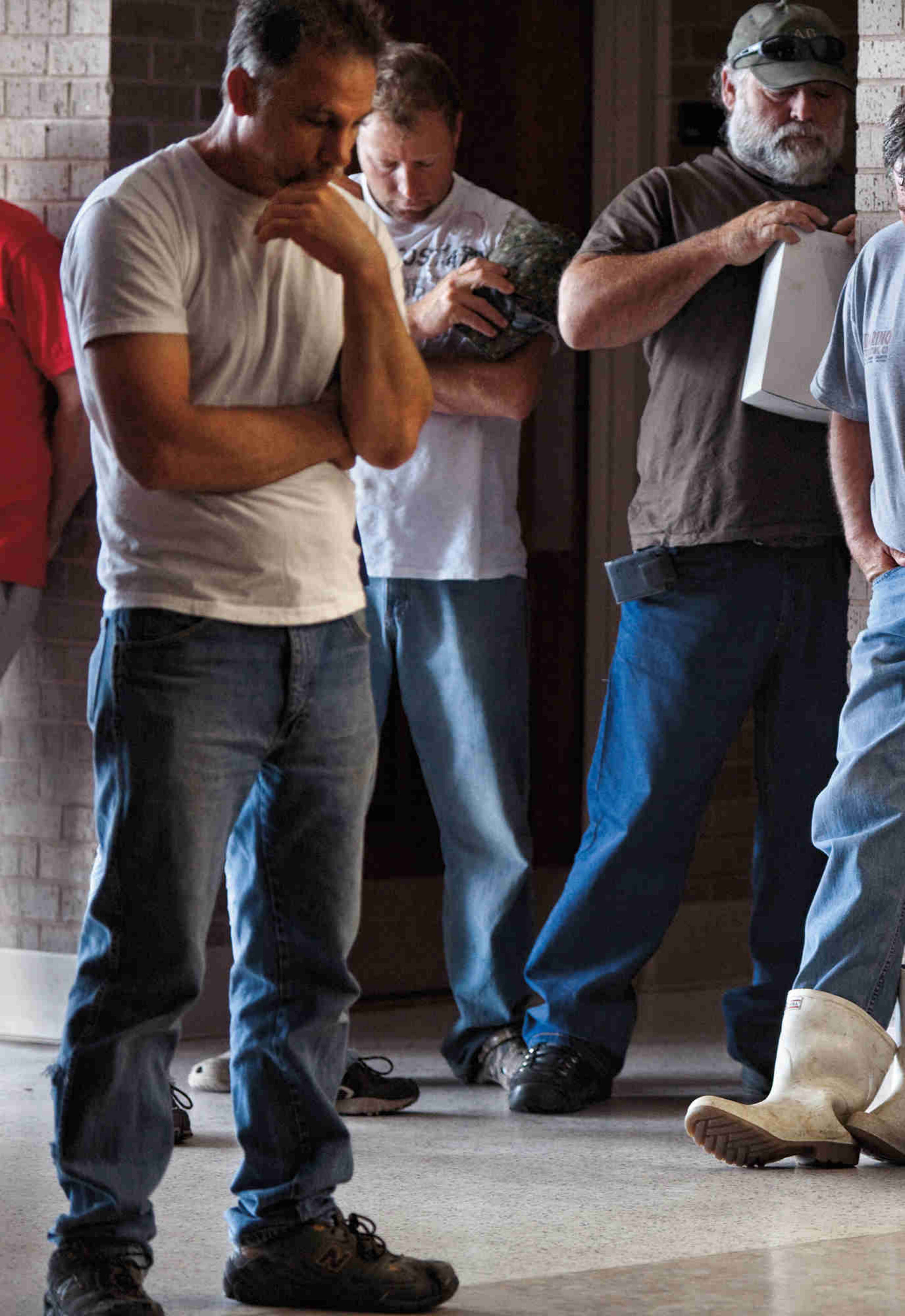






*Bottlenose dolphins slip through oiled waters in Chandeleur Sound, La. An adult dolphin can weigh up to 600 pounds. Because of their size, only a few were rescued and relocated to clean waters.*

ALEX BRANDON, AP IMAGES





*Their waters closed by the spill, fishermen in St. Bernard Parish, La., attended a May 1 BP training for cleanup crews—and bowed heads for an archbishop's impromptu prayer.*

TYRONE TURNER

# THE DEEP DILEMMA

*The largest U.S. oil discoveries in decades lie in the depths of the Gulf of Mexico—one of the most dangerous places to drill on the planet.*

BY JOEL K. BOURNE, JR.

ON A BLISTERING JUNE DAY in Houma, Louisiana, the local offices of BP—now the *Deepwater Horizon* Incident Command Center—were swarming with serious men and women in brightly colored vests. Top BP managers and their consultants wore white, the logistics team wore orange, federal and state environmental officials wore blue. Reporters wore purple vests so their handlers could keep track of them. On the walls of the largest “war room,” huge video screens flashed spill maps and response-vessel locations. Now and then one screen showed a World Cup soccer match.

Mark Ploen, the silver-haired deputy incident commander, wore a white vest. A 30-year veteran of oil spill wars, Ploen, a consultant, has helped clean up disasters around the world, from Alaska to the Niger Delta. He now found himself surrounded by men he’d worked with on the *Exxon Valdez* spill in Alaska two decades earlier. “It’s like a high school reunion,” he quipped.

Fifty miles offshore, a mile underwater on the seafloor, BP’s Macondo well was spewing something like an *Exxon Valdez* every four days. In late April an explosive blowout of the well had turned the *Deepwater Horizon*, one of the world’s most advanced drill rigs, into a pile of charred and twisted metal at the bottom of the sea. The

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*Joel Bourne is a contributing writer. His article about California’s water supply appeared in April.*





*The \$560-million Deepwater Horizon drilling rig burns after the April 20 well blowout. Eleven workers died in the explosion and flames that followed. On April 22 the rig sank.*

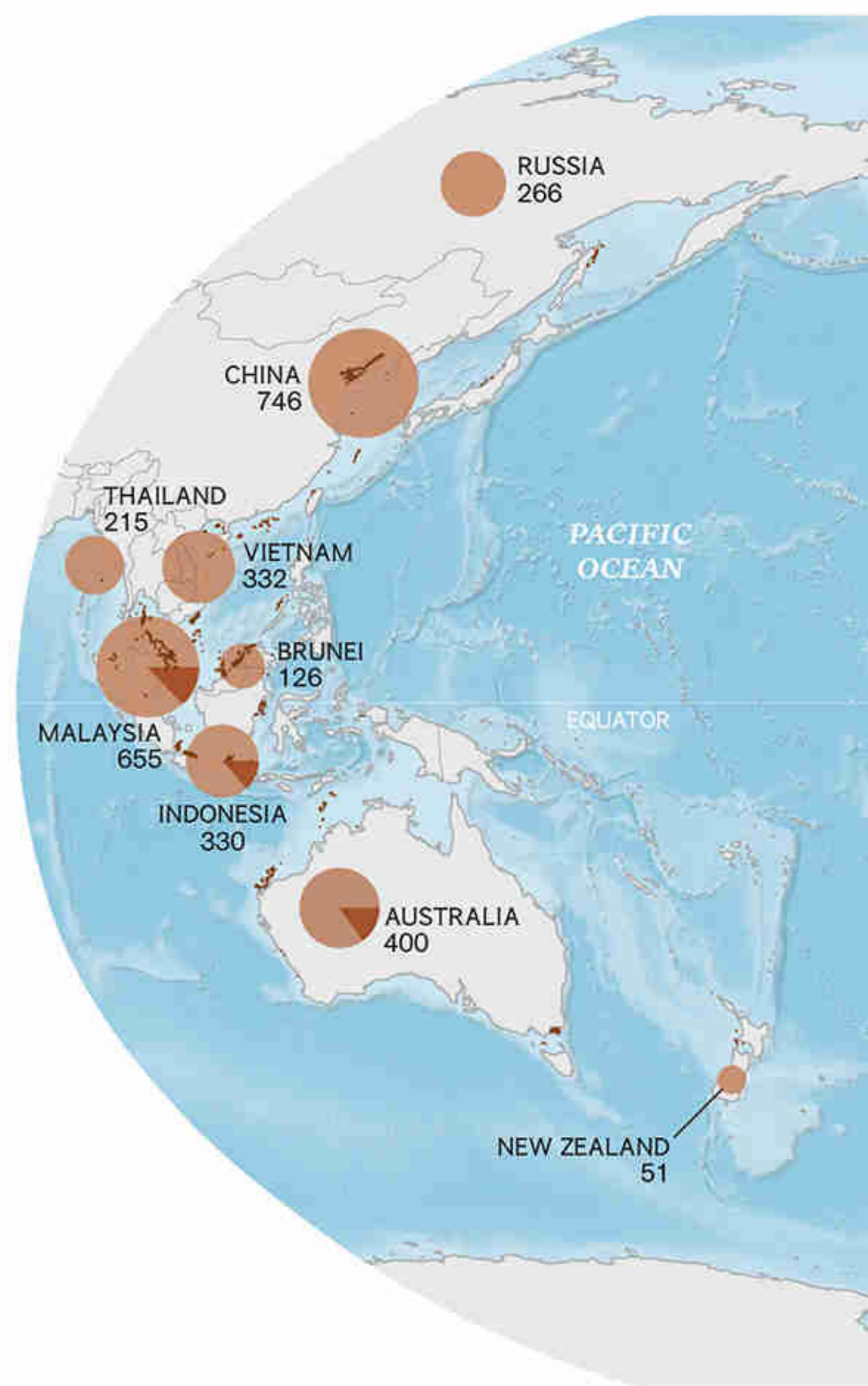
GERALD HERBERT, AP IMAGES

industry had acted as if such a catastrophe would never occur. So had its regulators. Nothing like it had happened in the Gulf of Mexico since 1979, when a Mexican well called Ixtoc I blew out in the shallow waters of the Bay of Campeche. Drilling technology had become so good since then, and the demand for oil so irresistible, that oil companies had sailed right off the continental shelf into ever deeper waters.

To many people in industry and government, spills from tankers like the *Exxon Valdez* seemed a much larger threat. The Minerals Management Service (MMS), the federal agency that regulated offshore drilling, had claimed that the chances of a blowout were less than one percent, and that even if one did happen, it wouldn't release much oil. Big spills had become a rarity, said Ploen. "Until this one."

In the Houma building, more than a thousand people were trying to organize a cleanup unlike any the world had seen. Tens of thousands more were outside, walking beaches in white Tyvek suits, scanning the waters from planes and helicopters, and fighting the expanding slick with skimmers, repurposed fishing boats, and a deluge of chemical dispersants. Around the spot Ploen called simply "the source," a small armada bobbed in a sea of oil. A deafening roar came from the drill ship *Discoverer Enterprise* as it flared off methane gas captured from the runaway well. Flames also shot from another rig, the *Q4000*, which was burning oil and gas collected from a separate line attached to the busted blow-out preventer. Nearby, two shrimp boats pulling fire boom were burning oil skimmed from the surface, creating a curving wall of flame and a towering plume of greasy, black smoke. Billions of dollars had already been spent. But millions of barrels of light, sweet crude were still snaking toward the barrier islands, marshes, and beaches of the Gulf of Mexico.

**T**HE WATERS of the Gulf below a thousand feet are a relatively new frontier for oilmen—and one of the toughest places on the planet to drill. The seafloor falls off the gently sloping continental shelf into jumbled



## DRILLING FOR OFFSHORE OIL

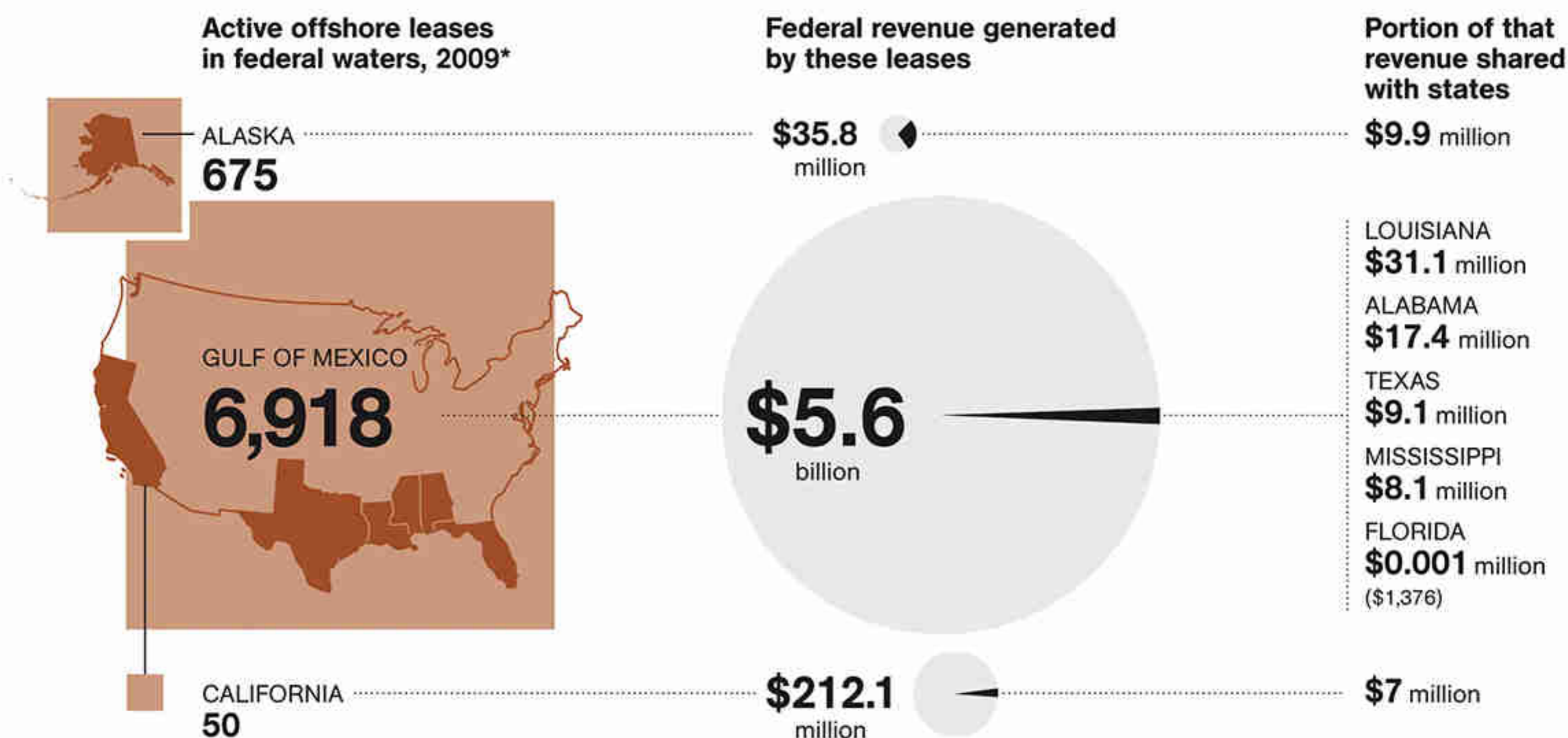
Undersea oil provides an increasing amount of the global supply, as exploration heads ever deeper in search of new "plays." In 2020 wells more than 400 meters below the sea surface will likely provide 10 percent of the world's oil. But going deep poses technical challenges and safety risks.

basin-and-range-like terrain, with deep canyons, ocean ridges, and active mud volcanoes 500 feet high. More than 2,000 barrels of oil a day seep from scattered natural vents. But the commercial deposits lie deeply buried, often beneath layers of shifting salt that are prone to undersea earthquakes. Temperatures at the seafloor are near freezing, while the oil reservoirs can hit 400 degrees Fahrenheit; they're like hot, shaken soda



# U.S. OFFSHORE LEASES

Offshore leases poured \$5.8 billion into federal coffers in 2009. Most of the money—\$5.6 billion—came from Gulf of Mexico wells, which have helped drive offshore oil's contribution to domestic production to 35 percent, up from 12 percent in 1981. Leasing is expected to resume once drillers adopt new federal safety standards.



2000. A fleet of new rigs was soon punching holes all over the Gulf at a cost of up to a million dollars a day each. The number of leases sold in waters half a mile deep or more shot up from around 50 in 1994 to 1,100 in 1997.

It wasn't long before the industry hit pay dirt. New fields with names like Atlantis, Thunder Horse, and Great White came just in time to offset a long-term decline in shallow-water oil production. The Gulf of Mexico now accounts for 30 percent of U.S. production, with half of that coming from deep water (1,000 to 4,999 feet), a third from ultradeep water (5,000 feet or more), and the rest from shallow water. BP's Macondo well, in about 5,000 feet of water and reaching another 13,000 feet beneath the sea-floor, wasn't particularly deep. The industry has drilled in 10,000 feet of water and to total depths of 35,050 feet—the latter a world record set just last year by the *Deepwater Horizon* in another BP field in the Gulf. The U.S. government estimates that the deep Gulf might hold 45 billion barrels of crude. "We're in deep water because

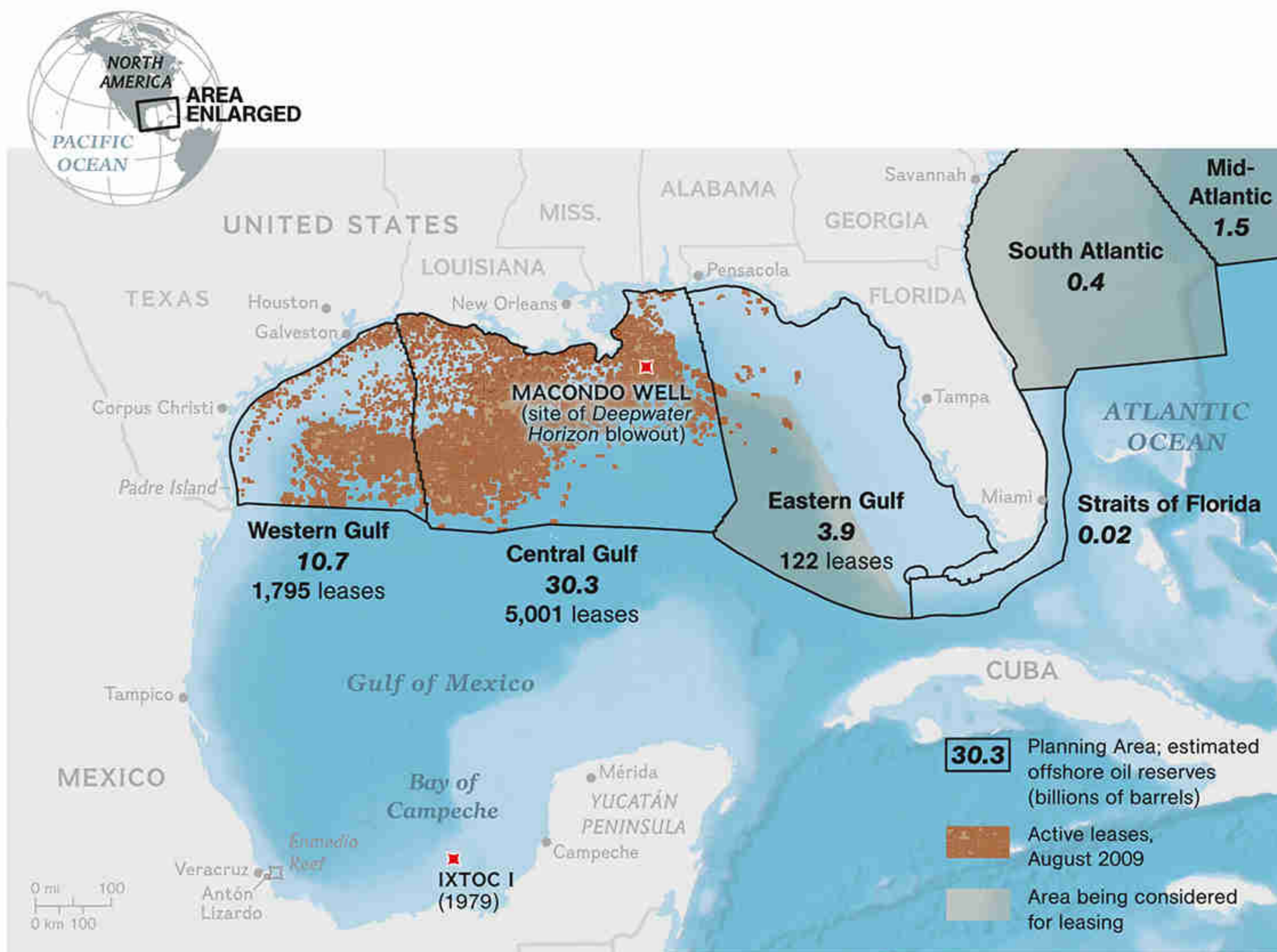
that's where the resources are," says Larry Reed, an operations consultant in Houston who has worked with many of the major oil companies. Deepwater wells tend to be highly productive, he adds, like wells in the Middle East.

As technology was taking drillers deeper, however, the methods for preventing blowouts and cleaning up spills did not keep pace. Since the early 2000s, reports from industry and academia warned of the increasing risk of deepwater blowouts, the fallibility of blowout preventers, and the difficulty of stopping a deepwater spill after it started—a special concern given that deepwater wells, because they're under such high pressure, can spout as much as 100,000 barrels a day.

The Minerals Management Service routinely downplayed such concerns. A 2007 agency study found that from 1992 to 2006, only 39 blowouts occurred during the drilling of more than 15,000 oil and gas wells in the Gulf. Few of them released much oil; only one resulted in a death. Most of the blowouts were stopped within a week,

\*ALASKA AND CALIFORNIA DATA AS OF SEPTEMBER 30, 2009; GULF OF MEXICO DATA AS OF AUGUST 18, 2009





typically by pumping the wells full of heavy drilling mud or by shutting them down mechanically and diverting the gas bubble that had produced the dangerous “kick” in the first place.

Though blowouts were relatively rare, the MMS report did find a significant increase in the number associated with cementing, the process of pumping cement around the steel well casing (which surrounds the drill pipe) to fill the space between it and the wall of the borehole. In retrospect, that note of caution was ominous.

**S**OME DEEPWATER WELLS go in relatively easy. The Macondo well did not. BP hired Transocean, a Switzerland-based company, to drill the well. Transocean’s first drill rig was knocked out of commission by Hurricane Ida after just a month. The *Deepwater Horizon* began its ill-fated effort in February 2010 and ran into problems almost from the start. In early March the drill pipe got stuck in the borehole, as did a tool sent down to find the stuck section; the drillers had to back out and drill around the

obstruction. A BP email later released by Congress mentioned that the drillers were having “well-control” problems. Another email, from a consultant, stated, “We have flipped design parameters around to the point that I got nervous.” A week before the explosion, a BP drilling engineer wrote, “This has been [a] nightmare well.”

By April 20 the *Deepwater Horizon* was six weeks behind schedule, according to MMS documents, and the delay was costing BP more than half a million dollars a day. BP had chosen to drill the fastest possible way—using a well design known as a “long string” because it places strings of casing pipe between the oil reservoir and the wellhead. A long string generally has two barriers between the oil and the blowout preventer on the seafloor: a cement plug at the bottom of the well, and a metal seal, known as a lockdown sleeve, placed right at the wellhead. The lockdown sleeve had not been installed when the Macondo well blew out.

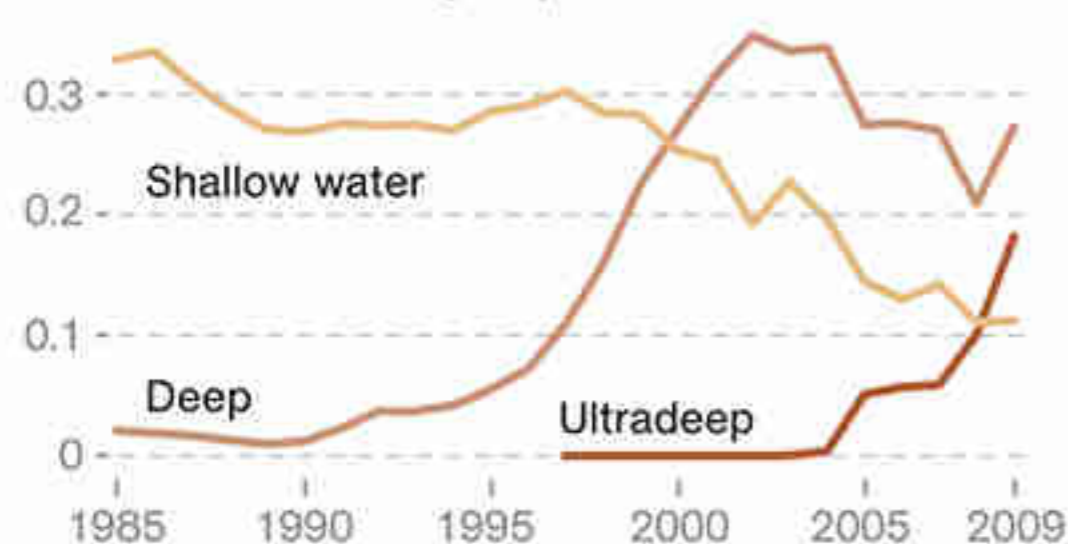
In addition, congressional investigators and industry experts contend that BP cut corners on

# DRILLING DEEPER

As oil and gas reserves close to shore have been pumped dry, prospectors are plumbing a new frontier: the depths of the Gulf of Mexico. In 2009 Gulf oil production jumped 34 percent—largely from waters deeper than 5,000 feet. New technologies have made it possible to drill more than 35,000 feet down through water and rock.

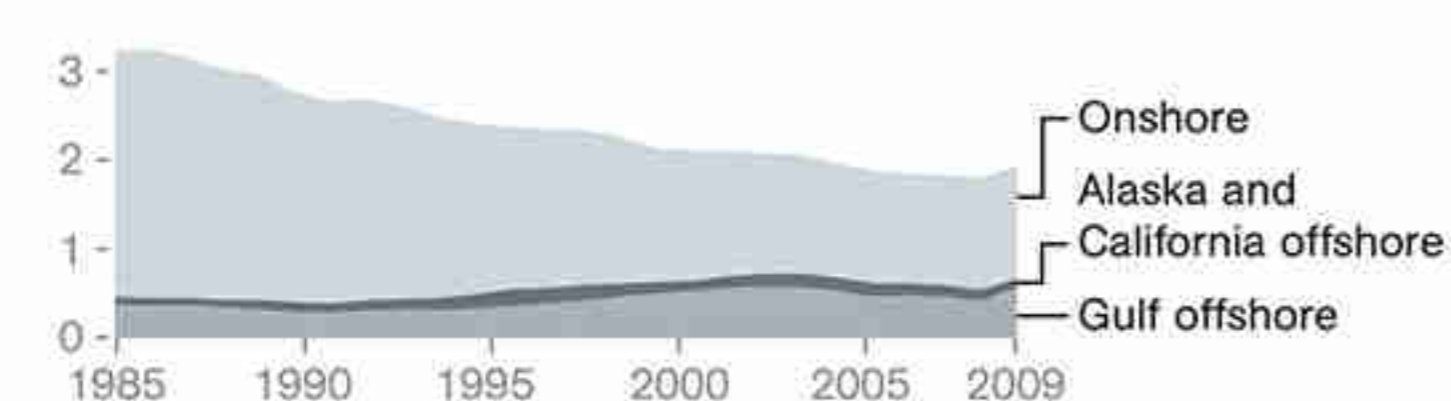
## U.S. Gulf oil from federal leases, 1985-2009

Billions of barrels, by depth



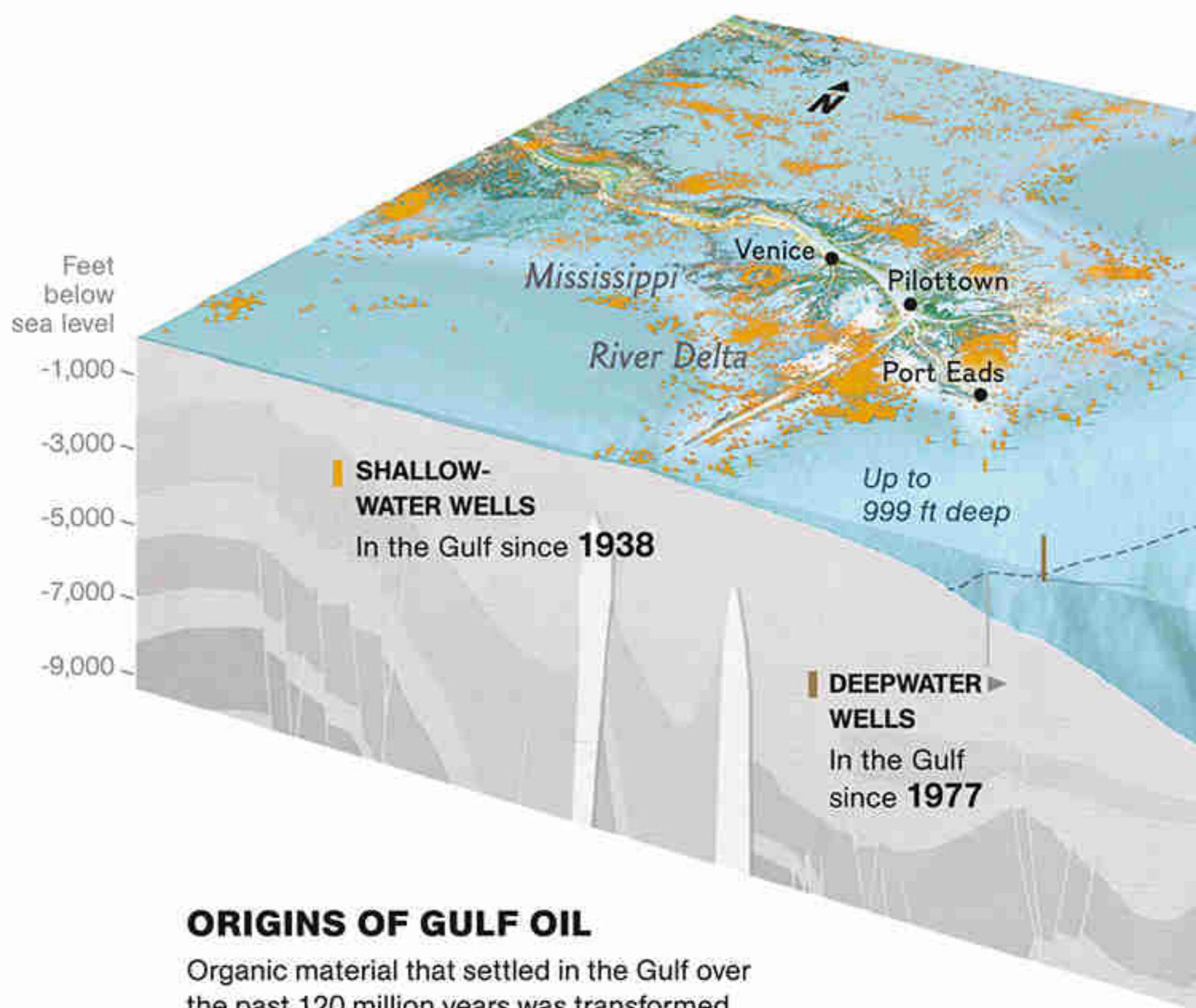
## U.S. domestic oil production, 1985-2009

Billions of barrels



its cement job. It failed to circulate heavy drilling mud outside the casing before cementing, a practice that helps the cement cure properly. It didn't put in enough centralizers—devices that ensure that the cement forms a complete seal around the casing. And it failed to run a test to see if the cement had bonded properly. Finally, just before the accident, BP replaced the heavy drilling mud in the well with much lighter seawater, as it prepared to finish and disconnect the rig from the well. BP declined to comment on these matters, citing the ongoing investigation.

All these decisions may have been perfectly legal, and they surely saved BP time and money—yet each increased the risk of a blowout. On the night of April 20, investigators suspect, a large gas bubble somehow infiltrated the



## ORIGINS OF GULF OIL

Organic material that settled in the Gulf over the past 120 million years was transformed into vast pools of oil and natural gas by time, pressure, and heat. The petroleum rises through faults until it is trapped by salt structures, some more than a mile below the seafloor.

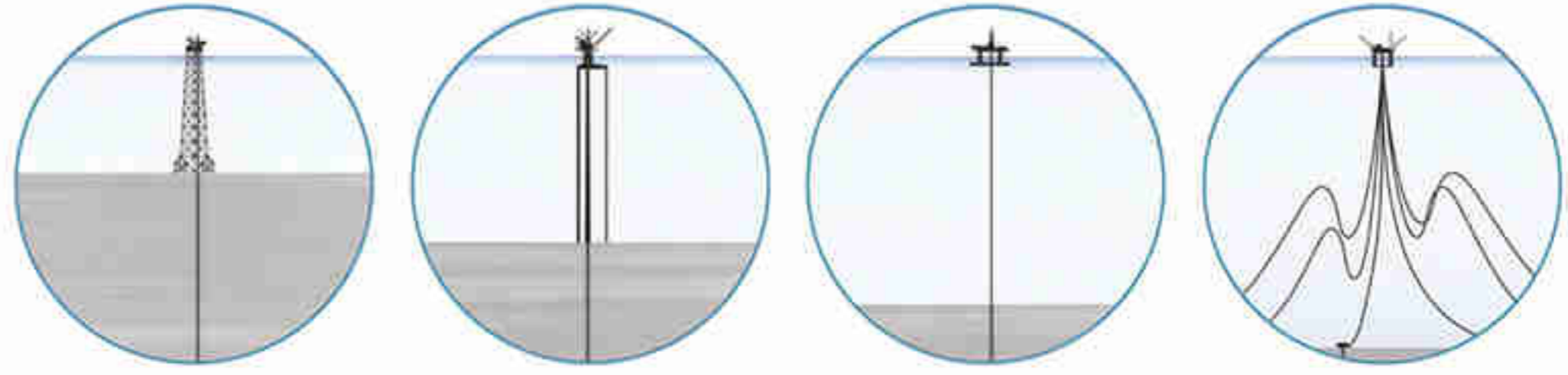
JUAN VELASCO, NGM STAFF. ART BY BRYAN CHRISTIE  
 SOURCES: RENAUD BOUROLLEC, COLORADO SCHOOL OF MINES, AND PAUL WEIMER, UNIVERSITY OF COLORADO (GEOLOGY AND BATHYMETRY); LOUISIANA DEPARTMENT OF NATURAL RESOURCES (SHALLOW-WATER WELLS); MMS (DEEP AND ULTRADEEP WELLS, OIL FROM FEDERAL LEASES); ENERGY INFORMATION ADMINISTRATION, OR EIA (U.S. PRODUCTION)

casing, perhaps through gaps in the cement, and shot straight up. The blowout preventer should have stopped that powerful kick at the seafloor; its heavy hydraulic rams were supposed to shear the drill pipe like a soda straw, blocking the upward surge and protecting the rig above. But that fail-safe device had itself been beset by leaks and maintenance problems. When a geyser of drilling mud erupted onto the rig, all attempts to activate the blowout preventer failed.

The way BP drilled the Macondo well surprised Magne Ognedal, director general of the Petroleum Safety Authority Norway (PSA). The Norwegians have drilled high-temperature, high-pressure wells on their shallow continental shelf for decades, he said in a telephone interview, and haven't had a catastrophic blowout

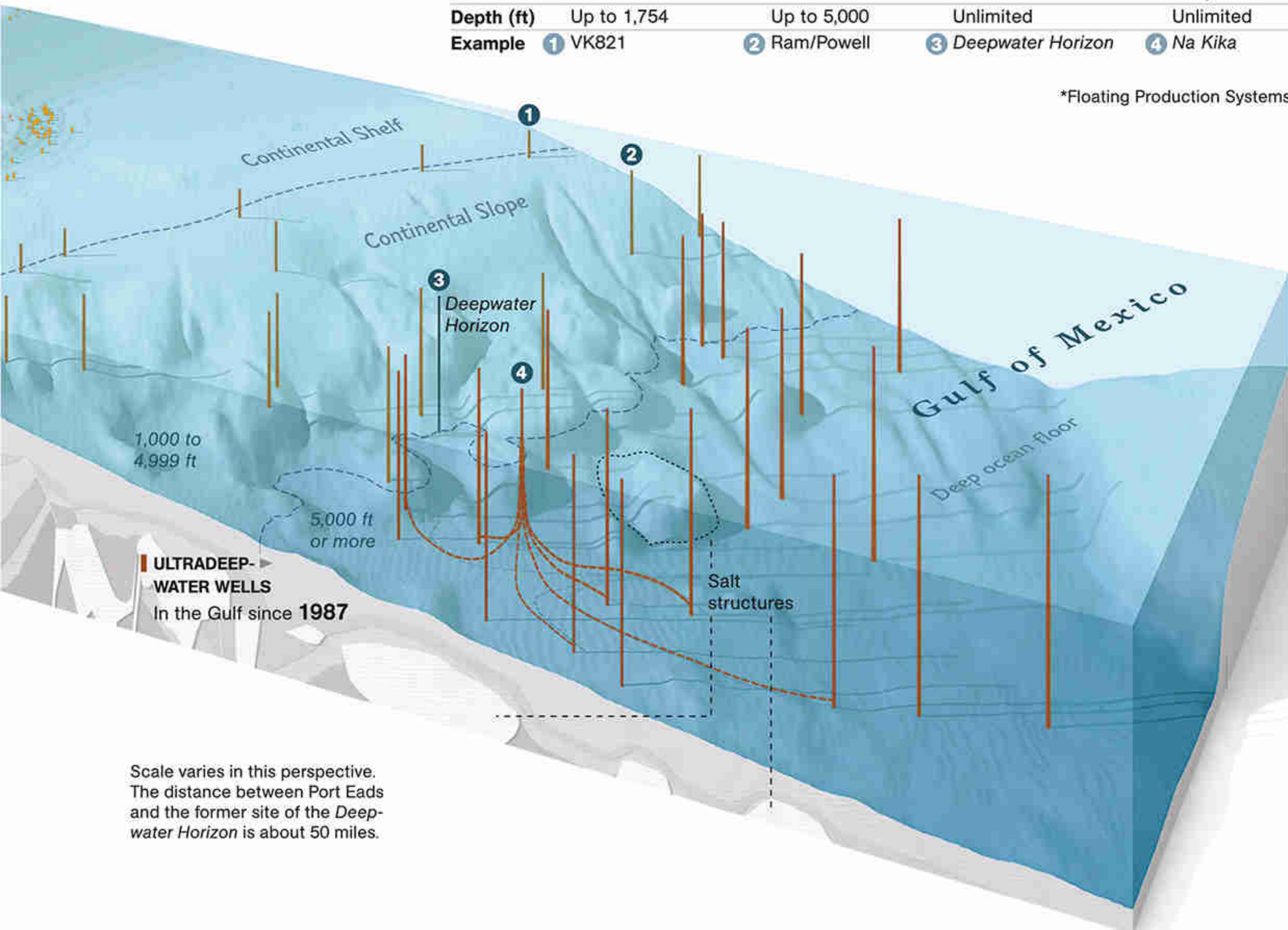
## SEAFARING RIGS

Floating rigs, first developed in the 1960s, have opened deep water to petroleum exploration. Floating platforms allow siphoning of oil from wells that can be many miles from shore.



Type	FIXED	TENSION-LEG	SEMISUBMERSIBLE	FPS*
First used	1938	1989	1963	Early 2000s
Depth (ft)	Up to 1,754	Up to 5,000	Unlimited	Unlimited
Example	① VK821	② Ram/Powell	③ <i>Deepwater Horizon</i>	④ <i>Na Kika</i>

\*Floating Production Systems



Scale varies in this perspective. The distance between Port Eads and the former site of the *Deepwater Horizon* is about 50 miles.

since 1985. After that incident, the PSA and the industry instituted a number of best practices for drilling exploration wells. These include riserless drilling from stations on the seafloor, which prevents oil and gas from flowing directly to a rig; starting a well with a small pilot hole through the sediment, which makes it easier to handle gas kicks; having a remote-controlled backup system for activating the blowout preventers; and most important, never allowing fewer than two barriers between the reservoir and the seafloor.

“The decisions [BP] made when they had indications that the well was not stable, the decision to have one long pipe, the decision to have only six centralizers instead of 21 to create the best possible cement job—some of these things

were very surprising to us here,” says Ognedal.

The roots of those decisions lie in BP’s corporate history, says Robert Bea, a University of California, Berkeley expert in both technological disasters and offshore engineering. BP hired Bea in 2001 for advice on problems it faced after it took over the U.S. oil companies Amoco and ARCO. One problem, Bea says, was a loss of core competence: After the merger BP forced thousands of older, experienced oil field workers into early retirement. That decision, which made the company more dependent on contractors for engineering expertise, was a key ingredient in BP’s “recipe for disaster,” Bea says. Only a few of the 126 crew members on the *Deepwater Horizon* worked directly for BP.

The drilling operation itself was regulated by





*“Mix two parts sugar white sand with one part crystal blue water,” reads a tourism slogan for Orange Beach, Ala. In early June Deepwater Horizon oil was added to the recipe.*

TYRONE TURNER

*BP's spill-response plan for the Gulf mentioned walrus and sea otters. It had been cut and pasted from plans for the Arctic.*

the MMS (which, in the wake of the accident, was reorganized and renamed the Bureau of Ocean Energy Management, Regulation, and Enforcement). In 2009 the MMS had been excoriated by the U.S. General Accounting Office for its lax oversight of offshore leases. That same year, under the new Obama Administration, the MMS rubber-stamped BP's initial drilling plan for the Macondo well. Using an MMS formula, BP calculated that the worst-case spill from the well would be 162,000 barrels a day—nearly three times the flow rate that actually occurred. In a separate spill-response plan for the whole Gulf, the company claimed that it could recover nearly 500,000 barrels a day using standard technology, so that even a worst-case spill would do minimal harm to the Gulf's fisheries and wildlife—including walrus, sea otters, and sea lions.

There are no walrus, sea otters, or sea lions

in the Gulf. BP's plan also listed as an emergency responder a marine biologist who had been dead for years, and it gave the Web address of an entertainment site in Japan as an emergency source of spill-response equipment. The widely reported gaffes had appeared in other oil companies' spill-response plans as well. They had simply been cut and pasted from older plans prepared for the Arctic.

When the spill occurred, BP's response fell well short of its claims. Scientists on a federal task force said in early August that the blown-out well had disgorged as much as 62,000 barrels a day at the outset—an enormous flow rate, but far below BP's worst-case scenario. Mark Ploen estimated in June that on a good day his response teams, using skimmers brought in from around the world, were picking up 15,000 barrels. Simply burning the oil, a practice that had been used with the *Exxon Valdez* spill,



had proved more effective. BP's burn fleet of 23 vessels included local shrimp boats that worked in pairs, corralling surface oil with long fire boom and then igniting it with homemade napalm. In one "monster burn" the team incinerated 16,000 barrels of oil in just over three hours.

"Shrimpers are naturals at doing this," said Neré Mabile, science and technology adviser for the burn team in Houma. "They know how to pull nets. They're seeing that every barrel we burn is a barrel that doesn't get to shore, doesn't affect the environment, doesn't affect people. And where's the safest place to burn this stuff? The middle of the Gulf of Mexico."

In June the *Discoverer Enterprise* and the *Q4000* began collecting oil directly at the busted blowout preventer, and by mid-July they had ramped up to 25,000 barrels a day—still far less, even when the efforts of the skimmers and the burn team were added, than the nearly 500,000

barrels a day BP had claimed it could remove. At that point the company finally succeeded in placing a tight cap on the well, halting the gusher after 12 weeks.

In 1990, after the *Exxon Valdez* spill, Congress's Office of Technology Assessment analyzed spill-response technologies and found them lacking. "Even the best national response system will have inherent practical limitations that will hinder spill-response efforts for catastrophic events—sometimes to a major extent," wrote OTA's director, John H. Gibbons. "For that reason it is important to pay at least equal attention to preventive measures as to response systems... The proverbial ounce of prevention is worth many, many pounds of cure."

Just weeks before the Macondo blowout, the Obama Administration had announced with some fanfare an expansion of offshore drilling. By summer the administration was struggling

## THE SPILL'S UNSEEN TOLL

Three formaldehyde-filled jars tell a tale of diminishing life in a water column about 90 miles north of the well. The May 4 sample (far left), collected by the Dauphin Island Sea Lab, Ala., shows a normal amount of plankton—minute plants and animals that are the foundation of the ocean's food chain. The June 2 jar holds only 40 percent of the first. The June 28 jar is down to 10 percent. Plankton cannot survive as waters become hypoxic—depleted of oxygen. The probable cause in this case: microbes digesting oil and methane gas from the spill.

Waters sampled about 35 feet deep on June 28 support a thriving population of tiny crustaceans called copepods (top right). Twenty feet farther below was a hypoxic layer almost devoid of life. Deep waters are more likely to remain hypoxic.



*When oil falls to the bottom, into the mud of a lagoon or a marsh, it can hang around for decades, degrading the environment.*

in court to preserve a moratorium on deepwater drilling until such time as it could be deemed safe. “In some cases I’m not confident that the industry is tapping these resources safely,” says Bea. “We can expect more of these in the future.”

**B**Y EARLY AUGUST BP seemed on the verge of plugging the Macondo well permanently with drilling mud and cement. The federal task force’s estimate of the amount of oil released stood at 4.9 million barrels. Government scientists estimated that BP had removed a quarter of the oil. Another quarter had evaporated or dissolved into scattered molecules. But a third quarter had been dispersed in the water as small droplets, which might still be toxic to some organisms. And the last quarter—around five times the amount released by the *Exxon Valdez*—remained as slicks or sheens on the water or tar balls on the beaches. The *Deepwater Horizon* spill had become the largest accidental spill into the ocean in history, larger even than the Ixtoc I blowout in Mexico’s Bay of Campeche in 1979. It is surpassed only by the intentional 1991 gulf war spill in Kuwait.

The Ixtoc spill devastated local fisheries and economies. Wes Tunnell remembers it well. The tall, 65-year-old coral reef expert at Texas A&M University–Corpus Christi earned his doctorate studying the reefs around Veracruz in the early 1970s, and he kept studying them for a decade after the spill coated them with oil. Tunnell wrote an early report on the impact there and on Padre Island in Texas. In early June, after the new disaster had once again raised the question of how long the impact of a spill can last, he returned to Enmedio Reef to see if any Ixtoc I oil remained. It took him three minutes of snorkeling to find some. “Well, that was easy,” he said.

Tunnell stood in the clear, waist-deep water of the protected reef lagoon holding what appeared to be a three-inch-thick slab of sandy gray clay. When he broke it in two, it was jet black on the inside, with the texture and smell of an asphalt brownie. Here on the lagoon side, where the reef looked gray and dead, the Ixtoc tar mat was still partially buried in the sediments.

But on the ocean side of the reef, where winds and waves and currents were stronger, no oil remained. The lesson for Louisiana and the other Gulf states is clear, Tunnell thinks. Where there is wave energy and oxygen, sunlight and the Gulf’s abundant oil-eating bacteria break it down fairly quickly. When oil falls to the bottom and gets entrained in low-oxygen sediments like those in a lagoon—or in a marsh—it can hang around for decades, degrading the environment.

Fishermen in the nearby village of Antón Lizardo hadn’t forgotten the spill either. “The Ixtoc spill about destroyed all the reefs,” said Gustavo Mateos Moutiel, a powerful man, now in his 60s, who wore the trademark straw hat of the Veracruzano fishermen. “Octopus gone. Urchins gone. Oysters gone. Conch gone. Fish almost all gone. Our families were hungry. The petroleum on the beach was halfway up our knees.” Though some species, such as Bay of Campeche shrimps, recovered within a few years, Moutiel, along with several other fishermen who had gathered on the beach, said it took 15 to 20 years for their catches to return to normal. By then two-thirds of the fishermen in the village had found other jobs.

Even in the turbulent, highly oxygenated waters of France’s Breton coast, it took at least seven years after the 1978 *Amoco Cadiz* spill for local marine species and Brittany’s famed oyster farms to fully recover, according to French biologist Philippe Bodin. An expert on marine copepods, Bodin studied the long-term effects of the spill from the grounded tanker. He believes the impact will be far worse in the generally calmer, lower-oxygen waters of the Gulf, particularly because of the heavy use of the dispersant Corexit 9500. BP has said the chemical is no more toxic than dishwashing liquid, but it was used extensively on the *Amoco Cadiz* spill, and Bodin found it to be more toxic to marine life than the oil itself. “The massive use of Corexit 9500 in the Gulf is catastrophic for the phytoplankton, zooplankton, and larvae,” he says. “Moreover, currents will drive the dispersant and the oil plumes everywhere in the Gulf.”

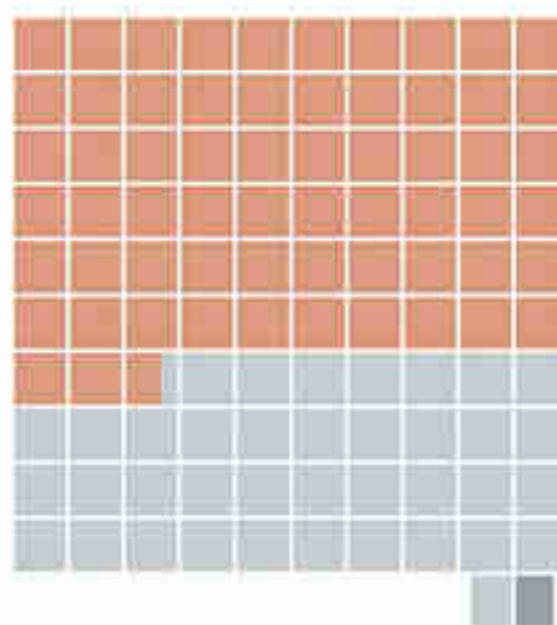
In May, scientists in the Gulf began tracking plumes of methane and oil droplets drifting up



## WORKING GULF

Oil dominates revenues from the Gulf, but the employment giant is tourism. Louisiana, regional leader in commercial fishing before the spill, normally harvests a third of the U.S. shrimp and oyster catch.

Annual Revenue  
**\$101.5** billion



1 block = \$1 billion

Jobs\*  
**645,000**



1 block = 6,324 jobs

\*Estimates

to 30 miles from the broken well, at depths of 3,000 to 4,000 feet. One of those scientists was University of Georgia biogeochemist Mandy Joye, who has spent years studying hydrocarbon vents and brine seeps in the deep Gulf. She found a plume the size of Manhattan, and its methane levels were the highest she had ever measured in the Gulf. As bacteria feast on spilled oil and methane, they deplete the water of oxygen; at one point Joye found oxygen levels dangerously low for life in a water layer 600 feet thick, at depths where fish usually live. Since waters in the deep Gulf mix very slowly, she said, such depleted zones could persist for decades.

BP was using old DC-3s set up like giant crop dusters to spray Corexit 9500 onto surface slicks. But for the world's first major deepwater spill, the company also got permission from the U.S. Environmental Protection Agency and the Coast Guard to pump hundreds of thousands of gallons of dispersant directly into the oil and gas spewing from the well, a mile beneath the surface. That helped create the deepwater plumes.

"The whole goal is to keep oil off the beaches, because that's what drives the economy," Joye said one day in June as she ran samples through her gas chromatograph aboard the R.V. *F. G. Walton Smith*. The little research ship was bobbing in an oily sheen a few miles from the busted well. "But now you've got all this material in the water column that no one is seeing and that you can't get rid of. If oil gets to the surface, about 40 percent evaporates. You can skim it, you can burn it, you can do something with it. But these tiny particles in the water column will persist for God knows how long."

Oceanographer Ian MacDonald at Florida

State University worries not only about the plumes but also about the sheer volume of spilled oil. He believes it could have a major impact on the overall productivity of the Gulf—not just on pelicans and shrimps in the Louisiana marshes, but on creatures throughout the region, everything from zooplankton to sperm whales. He's particularly concerned about bluefin tuna, which spawn only in the Gulf and in the Mediterranean; the tuna population was already crashing due to overfishing. "There is a tremendous amount of highly toxic material in the water column, both at the surface and below, moving around in one of the most productive ocean basins in the world," MacDonald said.

**D**URING THEIR JUNE cruise Joye's team sampled water within a mile of the *Discoverer Enterprise*, close enough to hear the apocalyptic roar of its huge methane flare. Researchers and crew members stood on the back deck of the *Walton Smith* and quietly took pictures. The caustic vapors of oil, diesel, and asphalt burned their lungs. As far as the eye could see, the cobalt blue waters of the deep Gulf were stained brownish red. When Joye went back inside she was in a pensive mood.

"The *Deepwater Horizon* incident is a direct consequence of our global addiction to oil," she said. "Incidents like this are inevitable as we drill in deeper and deeper waters. We're playing a very dangerous game here. If this isn't a call to green power, I don't know what is."

Americans burn nearly 20 million barrels of oil a day. In early August the U.S. Senate adjourned for the summer without taking up an energy bill. □



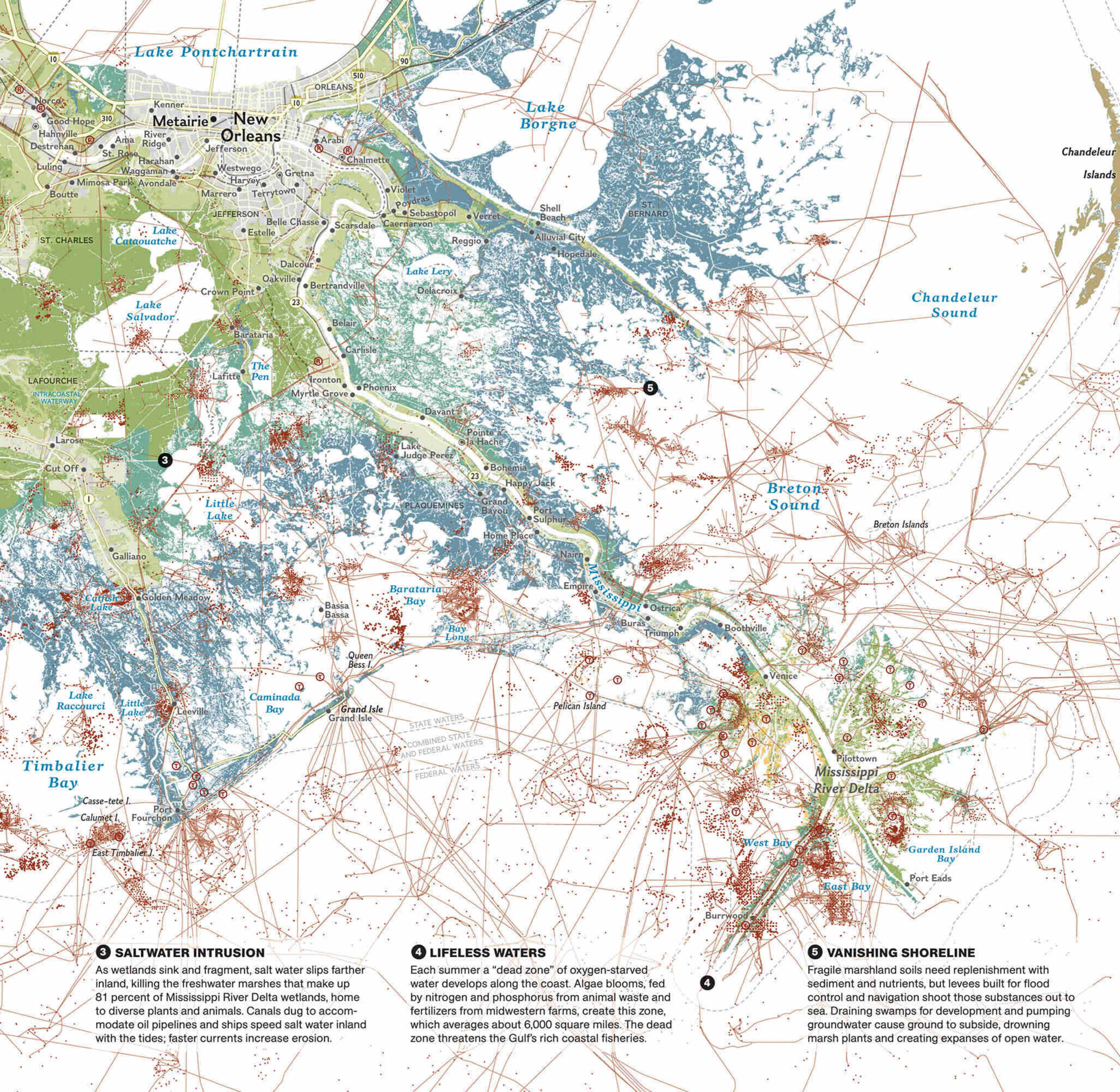
## GULF OF MEXICO

### 1 NEW DELTA LAND

On the Louisiana coast, new land is being formed in the Atchafalaya River Delta, as river sediment replenishes wetlands. Large-scale diversions of Mississippi and Atchafalaya river waters are proposed to feed the marshes but could interfere with deepwater navigation and key species like oysters.

### 2 OIL INFRASTRUCTURE

Since the 1940s, oil companies have built thousands of drilling platforms along Louisiana's coast. Tens of thousands of pipelines connect those rigs to shore. The oil industry pumps \$70 billion a year into the state; its rigs create a secure habitat for fish. But pipeline canals speed erosion, and the risk of spills is ever present.



## ENDANGERED WETLANDS

The *Deepwater Horizon* spill is just the latest threat to the Mississippi River Delta and its inhabitants. Both natural processes and human interference have submerged more than 2,300 square miles of coastal marshes. Nonetheless, the area is still one of the world's richest river deltas, home to shrimp and oyster fisheries, endangered sea turtles, millions of birds, a multibillion-dollar oil industry, and two million people. This map details the ongoing problems that confront the delta.

- Tidal flats and shoals
- Sea grass
- Saltwater marsh
- Intermediate marsh
- Freshwater marsh
- Other freshwater wetland
- Upland
- Urban area
- Oil or gas well
- Crude oil or gas terminal
- Oil refinery
- Oil or gas pipeline

0 mi 10  
0 km 10

### 3 SALTWATER INTRUSION

As wetlands sink and fragment, salt water slips farther inland, killing the freshwater marshes that make up 81 percent of Mississippi River Delta wetlands, home to diverse plants and animals. Canals dug to accommodate oil pipelines and ships speed salt water inland with the tides; faster currents increase erosion.

### 4 LIFELESS WATERS

Each summer a "dead zone" of oxygen-starved water develops along the coast. Algae blooms, fed by nitrogen and phosphorus from animal waste and fertilizers from midwestern farms, create this zone, which averages about 6,000 square miles. The dead zone threatens the Gulf's rich coastal fisheries.

### 5 VANISHING SHORELINE

Fragile marshland soils need replenishment with sediment and nutrients, but levees built for flood control and navigation shoot those substances out to sea. Draining swamps for development and pumping groundwater cause ground to subside, drowning marsh plants and creating expanses of open water.

WILLIAM McNULTY, NGM STAFF; DEBBIE GIBBONS AND MAUREEN J. FLYNN, NG MAPS; THEODORE A. SICKLEY  
 SOURCES: NOAA AND THE NATURE CONSERVANCY (LAND COVER); MMS AND LOUISIANA DEPARTMENT OF NATURAL RESOURCES, OFFICE OF CONSERVATION AND OFFICE OF COASTAL MANAGEMENT (OIL AND GAS INFRASTRUCTURE); LANDSCAN 2008 (URBAN AREAS)

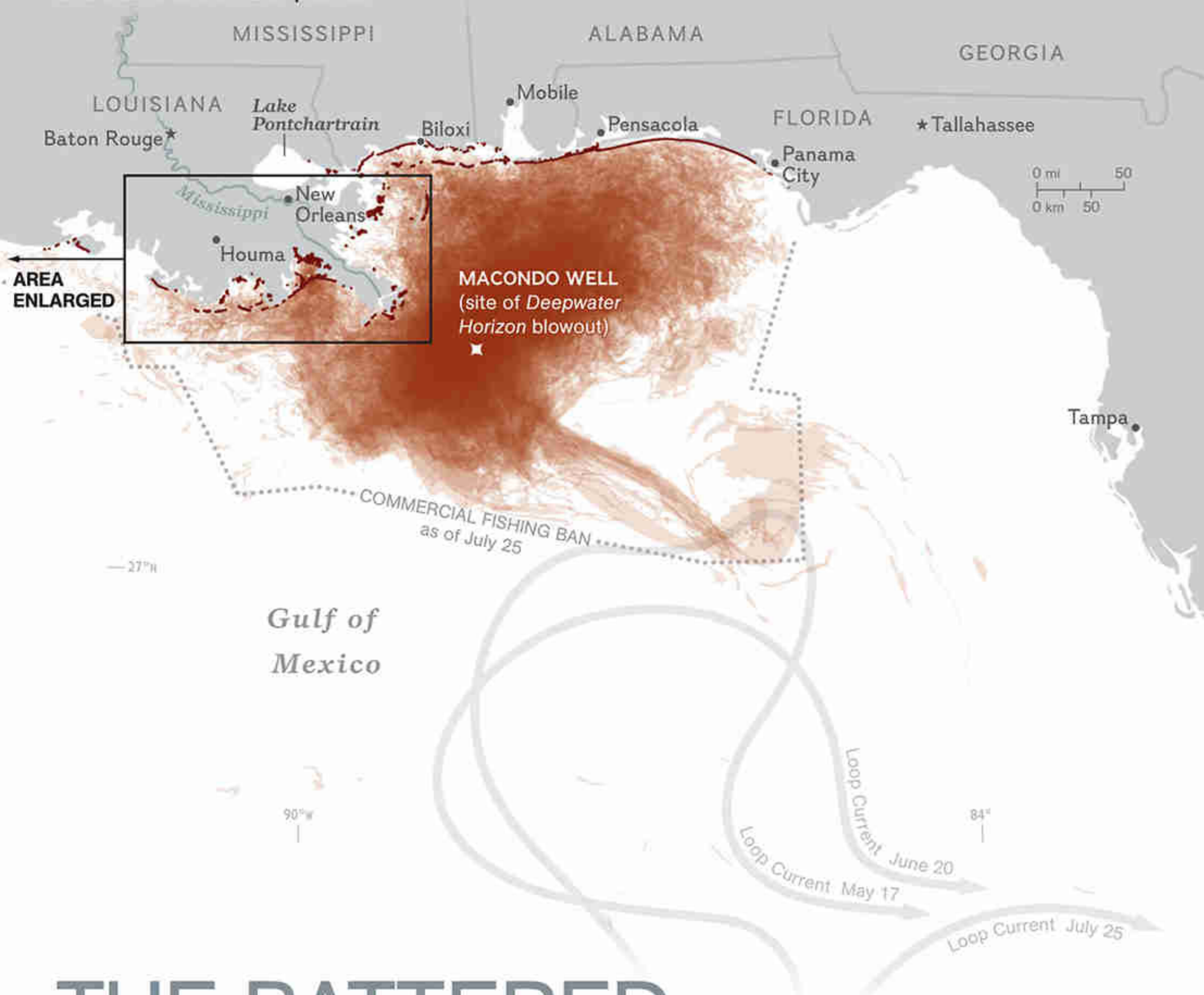
## AN OILY STAIN

Winds and currents spread surface oil, contaminating more than 625 miles of coastline, most in Louisiana. The spill prompted a fishing ban in one-third of federal waters (partly rescinded in late July) and a massive and ongoing cleanup effort. Experts believe much of the oil never reached the surface and remains in voluminous and elusive underwater plumes.

Surface oil\*  
Cumulative 1 day 10 30+  
daily survey

Oiled coast\* 

\*May 17-July 25, 2010



## THE BATTERED GULF COAST

Two centuries of efforts to tame the Mississippi River with levees, pumps, and channels have left its vast wetlands ecosystem dwindling and on the verge of collapse. "We know there was a crisis in the Gulf prior to what happened April 20," Tom Strickland, an assistant secretary of the interior, said after the *Deepwater Horizon* spill. Coastal-restoration plans have been authorized by Congress but are not yet under way. They include breaking open levees to restore the flow of rivers to marshlands. Environmentalists are lobbying to apply oil spill penalty funds to restoration.

*Canals carved through Golden Meadow, La., and elsewhere hold pipelines that deliver oil and gas from offshore wells. This chopping up of the wetlands is one of many forces contributing to the decline of the Mississippi Delta.*

JOEL SARTORE







*A dead juvenile sea turtle lies marooned in oil in Barataria Bay, La. More than 500 sea turtles died in the spill area. As of August 2, eggs from 134 turtle nests had been moved to oil-free beaches, and 2,134 hatchlings released.*



# FORLORN IN THE BAYOU

*Louisiana's wetlands are resilient and have bounced back before. But no one knows how long this recovery will take.*

BY BRUCE BARCOTT

WHERE LAND MEETS THE SEA in the Mississippi River Delta, down at the bottom of the Louisiana boot, the term “coastline” doesn’t really apply. There is no line. There are only the dashed pen strokes of the barrier islands, a dozen or so thin beachheads, and beyond, a porous system of open bays, canals, salt and brackish marshes, and freshwater swamps running inland for 25 to a hundred miles.

These are the Louisiana wetlands—12,355 square miles of one of the most productive ecosystems in North America. Mullet are so profuse they will literally jump into a fisherman’s boat. Brown pelicans, tricolored herons, roseate spoonbills, great egrets, and blue-winged teal ducks call this place home.

One-third of the United States oyster and shrimp crop comes out of the waters along the Louisiana coast. And 98 percent of the fish, shrimps, crabs, and oysters harvested along that coast depend on habitat in and around the marshes of the Barataria-Terrebonne estuary, an area that encompasses some four million acres south and west of New Orleans. Without these

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*Environmental journalist Bruce Barcott lives on Bainbridge Island, Washington. This is his fourth feature for National Geographic.*



*Workers bag oil-collecting pom-poms near a bird rookery in Barataria Bay, La. Absorbent boom snakes at their feet. By the end of July, the cleanup had generated almost 40,000 tons of solid waste.*

JOEL SARTORE





*It came in broken tendrils. It coalesced into purplish rafts.  
It was as thin as a rainbow sheen. It was as thick as taffy.*

marshes, bordered by the Atchafalaya River on the west and the Mississippi on the east (map, page 54), there is no shrimp fishery or oyster harvest; neither are there reeds and grasses for nesting and migrating birds. Without the marshes, the rich human culture of the bayou has no foundation.

"These are working wetlands," Gay Gomez, an author and naturalist who grew up on the Louisiana coast, told me. "The land, the wildlife, and the people are inseparable here."

That's why, on day 22 of the *Deepwater Horizon* oil spill, EPA Administrator Lisa Jackson declared that the federal government was doing everything in its power to keep the oil from reaching the marshes.

But within a month of the explosion, the oil came to the marshes.

IT DIDN'T ARRIVE in a simple, syrupy tide. It came in broken tendrils that slipped past the barrier islands and floated north on currents driven by a warm southern breeze. The oil changed shape as it moved. In one bay it speckled the water with brown turds and spit gobs. In another it coalesced into purplish rafts the size of small swimming pools. It was as thin as a rainbow sheen or as thick as carnival taffy.

Where it struck, it stuck. On Devils Point, a half-mile strip of saltwater marsh in Timbalier Bay, the oil glommed on to oyster grass stalks and mangrove leaves. In Redfish Bay, near the mouth of the Mississippi, it blackened the ankles of ten-foot-tall roseau cane stalks. On Barataria Bay's Queen Bess Island, one of North America's most productive bird rookeries, thick tide pools of oil hugged the shore and tarred the feathers of brown pelicans as they dived for food. Day after day, the wind pushed the oil farther into the marshes. Miles of absorbent and containment boom, often laid haphazardly and left unattended, could not stop it.

The marshes of Barataria-Terrebonne estuary are already the fastest disappearing lands on Earth. Starved of Mississippi River sediment and carved up by hundreds of oil- and gas-exploration canals, the marshes

are subsiding into open water at a rate of 15 square miles a year. "This oil is hitting a coast that's already sick," said Kerry St. Pé, director of the Barataria-Terrebonne National Estuary Program.

The locavore movement has become trendy in America's hipper zip codes, but down here folks have been living off locally grown food for hundreds of years. Roadside diners serve up shrimp po'boys, French bread stuffed with the fried pride of Barataria Bay. Children bait strings with chicken necks to catch blue crabs. On Sundays friends and family gather for local crawfish or crabs boiled in huge pots over propane burners.

So in the early days of the spill a harvest fever swept coastal Louisiana. Mitch Jurisich and his younger brother, Frank, oyster farmers in the coastal town of Empire, hired local fishermen to dredge their oyster beds in an effort to harvest before the oil hit. That lasted only a few weeks, though. By early June the fever had broken. Oil forced the closure of almost all oyster and shrimp grounds along the coast. "My subcontractors are all gone now," Mitch Jurisich told me. "They can make twice as much money laying boom for BP, and I can't blame 'em. I thought about going all out, working 14-hour days," he said. "But then I decided that I wasn't going to let BP dictate how I lived my life. We're running like normal now."

Every morning in predawn darkness Jurisich would pilot his oyster barge up the Empire Channel toward the shallow estuary of Adams Bay. Jurisich's grandfather, a Croatian immigrant, first raked these beds in 1904. Today Mitch and Frank lease some 14,000 acres of oyster beds from the state of Louisiana.

On June 4 the Jurisiches' oyster beds were among the last ones open in Barataria Bay. The oil was roughly six miles away. "The way this wind's blowing, it'll keep moving the oil closer inland," Mitch predicted. "I expect a call this afternoon telling us this is it," meaning a shutdown. With BP's well discharging tens of thousands of barrels a day, there was no way of knowing whether such a closure would last days,

weeks, or years. “It feels like we’re farming with a monster coming at us,” he said.

Two monsters, actually. There was more to fear than just oil.

“Usually by June the river falls, and the higher salinity signals the oysters to spit their larvae,” Jurisich said. But that wasn’t happening. Weeks earlier state officials had opened Mississippi River diversions to push fresh water through the estuary in a preemptive effort to keep the oil in the open Gulf. Oysters can tolerate wide variations in salinity, but they do need some salt in the water. If the fresh water kept flowing, Jurisich’s oysters might die without ever encountering oil. In fact, by late July, low salinity levels had begun to kill oysters in Barataria Bay.

As we reached the oyster beds, Jurisich released two dredges, which looked like chain-link bags embedded with steel tines. “Just like dragging a garden rake,” he said.

“Here they come!” Jurisich shouted, as clanging chains hauled up the steel dredges, and their contents clattered onto a metal sorting table. The air filled with *plink, plink*, like the sound of miners’ hammers hitting rocks, as Jurisich’s crewmen knocked the clumped oysters apart with culling hatchets. Fist-size oysters—the three-year-olds—went into burlap bags. Smaller ones were tossed overboard; those would take another year to reach market size.

In an average year the Jurisich brothers fill 50,000 burlap oyster sacks with about a hundred pounds of shell and meat each. “In a good year we’ll do three times that,” said Mitch. “And this was lining up to be a good year.”

The sun rose over the horizon, casting a warm glow over the barge. Jurisich basked in the moment. “Not only do we like to work out here, we like to play out here too,” he said. “If that oil puts us down, we’d lose a lot more than a livelihood. We’d lose our lifestyle.”

Like most locals, Jurisich hates the oil but not the industry that spilled it. “Oyster farmers and oil and gas companies have been working here in the same place for more than 50 years. We maintain good relations. No more oil and gas due to this spill?” he asked, and paused. “No. I

don’t want that. Seafood alone couldn’t support this state.” He looked out at the water. “This will be a temporary bump in the road.” There was a catch in his voice, a note of forced optimism. As if speaking the words would propel them toward truth.

That night a fresh pulse of oil hit Barataria Bay. A day later the oyster grounds were closed by the state health department. Jurisich Oysters LLC was out of business.

**T**HE HISTORY of oil spills in marshes is a litany of hard lessons learned.

Lesson: Removing oiled sediment from a saltwater marsh can completely destroy the marsh (spill from the *Amoco Cadiz* in France’s Île Grande marsh, 1978). Lesson: Burning oil out of a marsh will not necessarily speed its recovery (pipeline spill in the marsh of Copano Bay, Texas, 1992). Lesson: Cutting—and in the process trampling—heavily oiled vegetation may kill off the marsh much faster than the oil itself would (*Eso Bayway* spill near Port Neches, Texas, 1979).

One more lesson: The phrase “after Katrina” may have a lot of meanings in coastal Louisiana, but during the oil spill it became shorthand for an awareness that the federal government would not ride to the rescue. If Louisianans wanted the marshes protected, they would have to do it themselves.

Mark Kulp is one of them. Kulp is an associate professor of geology at the University of New Orleans who specializes in coastal lands. When the *Deepwater Horizon* spill occurred, he was recruited as a team leader by BP’s Shoreline Cleanup Assessment Technique (SCAT) division. Every day at 6 a.m. six SCAT teams would fan out across the Louisiana coast in airboats to investigate reports of oiled shoreline and recommend cleanup protocols. On the morning of June 12 Kulp was in the SCAT room in the Houma Incident Command Center. A wildlife biologist, an environmental-quality specialist, and an archaeologist rounded out his team for the day.

“I want to check out a spot in Timbalier Bay



*In mid-May pools of oil moved into Louisiana's wetlands. BP boats laid yellow and orange boom to corral the oil for cleanup, white boom to soak it up. Oil covered the grass, but by mid-July new growth had sprouted.*

TED JACKSON, TIMES-PICAYUNE



*The federal government would not ride to the rescue. If Louisianans wanted the marshes protected, they would have to do it themselves.*

that was heavily oiled two weeks ago,” Kulp said. He showed me pictures of dark reddish-brown oil gunked on the shore at Devils Point. “It was pretty badly hit.”

Kulp had recommended no radical cleaning. “We had them run some boom to suck oil from the water along the shoreline. I’m hoping the tidal action will slowly wash the oil out of the vegetation and into the boom.” The material in the boom is hydrophobic (water repellent) and oleophilic (oil absorbent). So when oil touches it, the boom won’t let it go.

Three hours later an airboat dropped us off on Devils Point. We slogged ashore at high tide. Nearly the entire peninsula was under six inches of water. “What I want to know is if the oil is moving into the interior, or if it’s staying on the fringe,” Kulp said.

It took about five minutes to make our way across. The news was mostly good. Some mangrove leaves had gone black, and some areas of glasswort were still lightly oiled. But the tidal and wave action had worked like a washing machine agitator, lifting the oil off the plants and moving it onto the white boom, which was now black with oil.

Back at SCAT headquarters that evening, division leader Ed Owens brought his 45-member staff together for a half-hour debriefing. Owens, a bigger-than-life British man with a rakish eye patch, came up with the SCAT concept while working on the *Exxon Valdez* response. Each SCAT team reported on what it had found.

“Team two. Mark?”

Kulp nutshelled it. “We went back to Devils Point, where we’re seeing progressive flushing with the tides. If we keep changing out the dirty boom, I think the high tides will continue doing us some good.”

One of the other SCAT teams reported that the beach on East Grand Terre, a barrier island, was still full of pooled oil. “This is the poster child right now,” the team leader said. “We need to get a cleanup team out there.”

Owens sighed. In this complex cleanup operation, the assignment of cleanup crews was beyond his purview. He could recommend, but

he could not dispatch. That was the job of the operations division.

“We’ll go to ops tonight and tell them they’ve got to get on this now,” Owens said, clearly frustrated at the thought of yet another delay. As the meeting broke up, he turned to his deputy. “We’re going to have to kick some ass on that Grand Terre situation.” Whether that would result in any action, nobody could say.

Kulp stayed late filling out a report on Devils Point. It might get filed in the bureaucratic ether. Or somehow it might make a difference in the recovery of Timbalier Bay. On his computer screen he called up a photo of the oil from his original visit to Devils Point. “It certainly looks a lot less scary than when I saw it two weeks ago,” he said. “With what we saw today, I do feel a sense of hope.”

CLEANING OIL from the marshes is one thing. Cleaning the wildlife that lives in the marshes is another thing entirely. BP had hired dozens of wildlife professionals to collect oiled birds and turtles, but they were often overwhelmed by the workload. That led to frustration and sometimes improvisation.

Every morning in early June the Plaquemines Parish coastal director, P. J. Hahn, met a fishing guide named Dave Marino at 4:45 in the refinery town of Port Sulphur, and the two of them went oil scouting. Hahn needed to know where the oil was washing up. Marino, his business wrecked by oil, was happy to have the work.

On the morning of June 5 Hahn said to Marino, “We better take a look at Queen Bess.”

A 97-acre clump of oyster grass and shell midden, Queen Bess Island is one of the fragile masterpieces of Barataria Bay. When Louisiana reintroduced the extirpated brown pelican in the late 1960s, Queen Bess became a primary nesting ground. In 1990 coastal-restoration advocates ringed the island with a rock barrier to keep it from sinking into the bay. Hundreds of brown pelicans, Forster’s terns, and laughing gulls now flock there annually to nest.

Hahn glassed the shore as we approached the island. “It’s getting worse over here,” he said.



*Workers wipe oil from marsh grass in St. Tammany Parish, La. It does look silly, a parish spokesman concedes, using diaper-like cloths to “wipe up seven billion blades of grass.” But the task helped gauge the degree of marsh grass contamination, which turned out to be small, and provided oil samples for testing. Below, rust-colored crude oil coats a blue crab’s face and claws at Grand Isle State Park, La.*



*“Got no shrimp, and nobody to buy ’em if we did,”  
said one vendor. “Everybody’s scared to eat it.”*

Dozens of brown pelicans stood at the shoreline, mustered like sailors at the rails, preening oil from their feathers. Some held their oil-heavy wings outstretched trying to dry them in the breeze. Others batted their wings in the water, trying to wash the feathers clean.

Marino spotted something caught near shore. Hahn waded in. It was a brown pelican, trapped in a tide pool of oil six inches deep. The bird was so oil soaked it could barely move. Oil dripped from its bill. The blink of its eye was the only sign that it was alive.

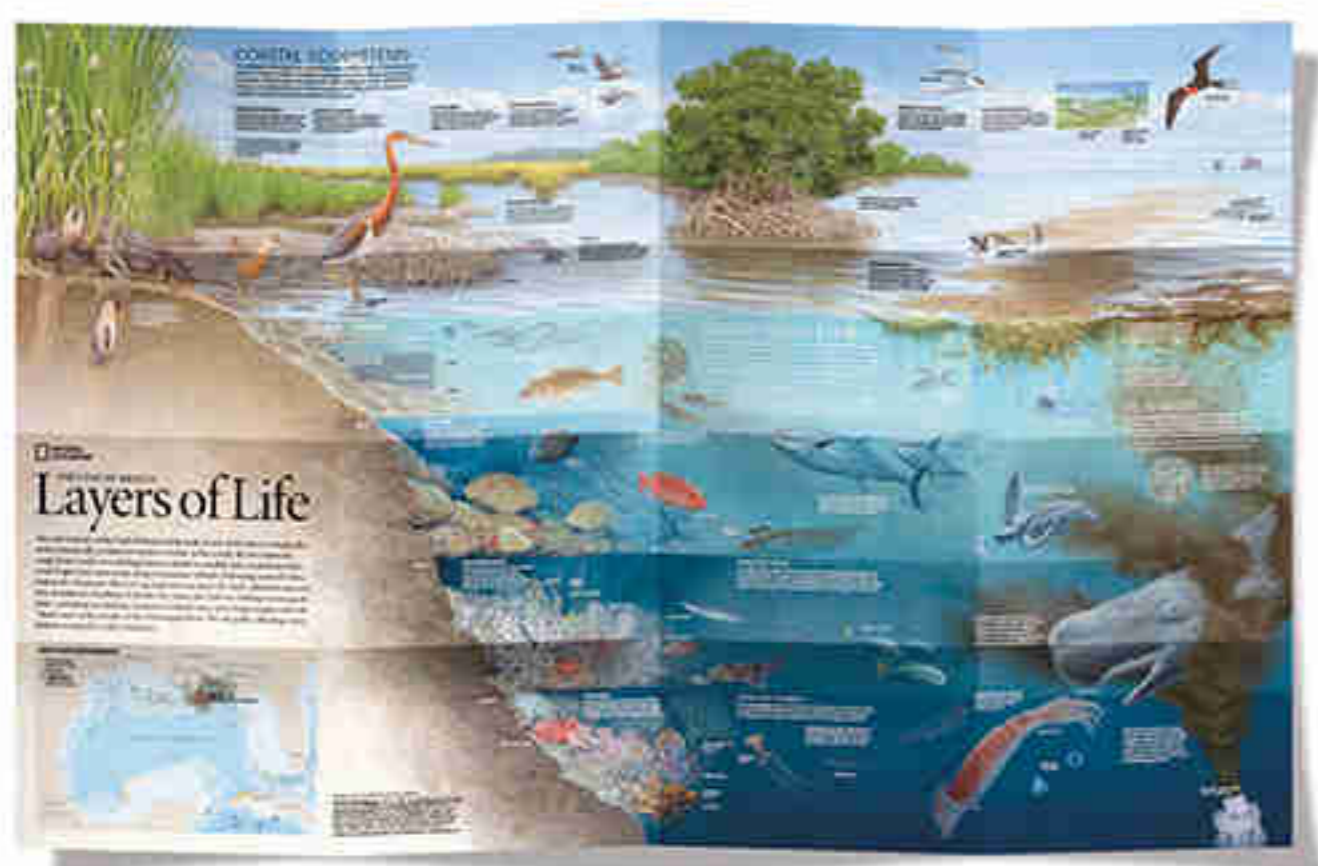
“I’ll call it in,” said Marino.

An hour and a half passed. Then two. Heat came into the morning. Help did not arrive.

Oiled birds don’t commonly die from poisoning. They usually freeze or fry. Oil destroys the insulative properties of their feathers, and they die of hypothermia when the nighttime temperature drops or of hyperthermia when the daytime sun overheats their bodies. This bird was being slowly cooked.

Hahn began to boil.

For weeks officials like Hahn and his boss, Plaquemines Parish President Billy Nungesser—the Fiorello La Guardia of the Louisiana coast—had complained bitterly about the chaotic operation run by BP and the federal government.



The special two-sided supplement that comes with this issue explores the rich **Layers of Life** in the Gulf of Mexico and maps the **Geography of Offshore Oil**.

*Fighting Back—Stories From the Spill* premieres September 28 at 9 p.m. on the National Geographic Channel.

Thousands of National Guard troops, Coast Guard reservists, and specialized contractors had overrun small fishing towns along the coast, but in all the hullabaloo few seemed able or willing to actually skim much oil from the water. Federal officials seemed more concerned with enforcing bureaucratic regulations than with cleaning up the spill. As far as Hahn was concerned, it was time to put the damn bird in the damn boat.

“I’m taking that bird in myself,” he said.

“You’re going to get us in trouble, P. J.,” said Marino. The rule on the water was: Don’t touch the birds.

“I can’t leave her here. She’s gonna die.”

Hahn raised the bird by its wing (photo, page 32)—not the best way to do it, but he had to take a chance—held its beak, and wrapped its body in a plastic bag to calm it. We carried it to Marino’s boat; the sopping, sun-heated bird felt as warm as fresh bread. Twenty minutes later it was on its way to the bird rehabilitation center south of Empire.

It went like that all that day and the next. In Bay Jimmy heavy oil browned the marsh grass. On an unnamed island in Bay Ronquille hermit crabs scuttled through oil and died.

In Bay Long the oil pooled in floating rafts so thick that two menhaden minnows leaped out of the water, got stuck in the thick crude, and died. Hahn dialed his office. “Donna?” he said. “I’m in Bay Long, and it’s heavy here. We just passed some skimmer boats over by Cat Island. We need to move them over here. North 29 degrees, 19.92 minutes. West 89 degrees, 49.45 minutes. You get that?”

Donna Frederick, the parish’s emergency operations center supervisor, repeated the coordinates.

“Great. We gotta move those skimmers. There’s a whole bunch about to hit the marsh here.”

Eventually Hahn and Marino turned back to port. They were exhausted. Marino’s boat bore the brown smudges of oiled-water duty. As they entered Myrtle Grove Marina, two Coast Guard officers in an airboat pulled alongside.

“Y’all been out playing in the oil?” one of the officers asked. He glared at Marino and Hahn



like a vice principal nabbing a couple of truant eighth graders.

“You need to go back and get deconned,” the officer said, indicating Marino’s stained hull. He pointed to a decontamination station where men wearing Tyvek suits held pressure washers. “You’re polluting the water with that oil,” he added, without a trace of irony.

**I**N THE SMALL TOWNS along Highway 23 and Highway 1, the two main arteries into the marsh country, restaurants replaced “Shrimp Boil” signs with “Crawfish Boil.” (Crawfish thrive in freshwater swamps, which have been largely untainted by oil and will remain so unless a huge storm surge sweeps it in.) Handmade protest signs sprouted in front yards. “Damn BP. God Bless America,” read one. Another was perched on an old toilet. “BP Headquarters,” it said.

At the Shrimp Lot in Westwego, where locals buy buckets of fresh-caught seafood from two dozen vendors, a normally packed parking lot sat empty. “Got no shrimp, and nobody to buy ‘em if we did,” one vendor told me. “Everybody’s scared to eat it.” Indeed, it is not known how the toxic blend of oil and dispersants will affect marsh life.

Along the docks and marinas there was fear that the oil would kill everything it touched. Certainly it would taint the marshes for years to come. A rumor circulated that the beach on Alaska’s Prince William Sound still held subsurface crude oil more than 20 years after the 1989 *Exxon Valdez* spill. It didn’t help that the Alaska rumor happened to be true.

Still, over the past 30 years we’ve learned a lot about the effects of spilled oil in various environments. And the research indicates that in the battle against the *Deepwater Horizon* oil, the Louisiana marshes have more than a puncher’s chance.

In fact, Barataria Bay has a number of things going for it. The Louisiana sweet crude glooping up its shores has been heavily weathered, which means some of its toxic components—the benzene, toluene, and naphthalene that can kill most organisms—have degraded on the

journey from the oil’s offshore source. Because weathered crude is highly viscous, it’s less likely to penetrate deep into marsh sediments. That’s good, because surface heat, sunshine, and water will help break down some components of the oil, as will oil-eating bacteria.

“A lot of people want to add microbes to clean up this spill,” the national estuary program’s Kerry St. Pé told me. “But we have plenty of natural microbes that consume oil already in our marshes.”

Those natural microbes are abundant partly because smaller spills are so common here. Although a *Deepwater Horizon*-size spill—about 200 million gallons until the flow was stopped in mid-July, most of which had not drifted into the marshes—is unprecedented in U.S. waters, over the past 40 years an annual average of 383,040 gallons of oil have spilled into the Gulf of Mexico from pipelines, platforms, and wells. An additional 41 million gallons discharge every year from natural seeps in the Gulf seafloor.

St. Pé’s ancestors settled here in 1760. As a boy, he hid in muskrat dens during games of hide-and-seek. Before he hired on at Barataria-Terrebonne, St. Pé spent 25 years managing oil spill cleanups for the Louisiana Department of Environmental Quality. Few in the state of Louisiana have seen more oil in the marshes.

After a day’s survey of Barataria Bay, St. Pé seemed more relieved than alarmed. “I’ve had oil spills far more ecologically challenging than this one,” he said. In 1997 a broken pipeline in Timbalier Bay spilled nearly 6,500 barrels of crude oil directly into the marshes. “That spill covered everything in sight,” St. Pé recalled. Yet within five months more than 4,100 acres of lightly oiled marshland had recovered. Of the 162 acres that had been heavily oiled, 161.72 acres recovered within two years.

“Crude oil isn’t a systemic herbicide” like Roundup, St. Pé explained. It may kill the tops of plants like oyster grass or roseau cane by smothering the stalks. “But the root system won’t die,” he said, “and within weeks the rhizomes in the sediment will send up new shoots.”

Black mangroves are at greater risk, because oil may block their pneumatophores, the long

*Oil-stained brown pelican chicks  
huddle on Cat Island, a barrier  
island forming the westernmost point  
of Gulf Islands National Seashore.  
Unsullied juveniles stand behind.*

JOEL SARTORE





*We carried the pelican to the boat. The sopping, sun-heated bird felt as warm as fresh bread.*

fingerlike breathing tubes that provide oxygen to the tree's underwater roots. "Even a light sheen can clog those tubes," St. Pé said as we scrutinized a number of empty pelican nests in the mangroves on Cat Island. Their oiled residents had been caught and taken to the rehab center the previous day.

As we drifted along the shore of Cat Island, gobs of oil floated by, fraying at the edges in the 97-degree heat. "It's degrading pretty quickly," said St. Pé. "The hot Louisiana sun can induce a lot of photooxidation and evaporation," he said. "And oil-consuming bacteria will multiply quickly now, because there's lots of food."

For the marshes of the Barataria-Terrebonne estuary, the damage done by the oil spill didn't compare with the damage done by decades of canal cutting and sediment starvation, St. Pé said. "The ecological effects of this will gradually subside. But the socioeconomic impacts will be devastating. No oysters, at least in the near future. No crabbing. No fishing. No seafood to restaurants. Nobody buying ice or bait or marine supplies. Lost paychecks with the offshore-drilling moratorium. Those impacts will stay for a long time."

**O**NE EVENING in early June I drove down to the Grand Isle shore and watched coin-size gobs of oil wash up in the surf. The beach at Grand Isle has become famous for visits from President Barack Obama and clean-up crews scooping oil out of sand. But on this night it was deserted. The only sound was a light whoosh from the waves.

Then I spotted two birds flying low from the east along the tide line. It took me a moment to identify them. Oystercatchers? No. By their motion they revealed themselves. They were black skimmers, which catch small fish by dipping their lower bills into the top three inches of water as they fly. As they flew past, I watched them skim water poxed with oil. I wanted to wave them away, flash a warning sign, scare them off. But it was too late. They continued down the shore, skimming and skimming and skimming. □



*A brown pelican rests at the Fort Jackson Bird Rehabilitation Center in Buras, La., after a cleaning. Only a tiny fraction of birds are retrieved and released. No one yet knows how oil and dispersants will affect reproduction.*

JOEL SARTORE



# MY BLUE WILDERNESS



**BY SYLVIA EARLE**

WHEN I FIRST VENTURED INTO THE GULF OF MEXICO IN THE 1950S, THE SEA appeared to be a blue infinity too large, too wild to be harmed by anything that people could do. I explored powder white beaches, dense marshes, mangrove forests, and miles of sea grass meadows alive with pink sea urchins, tiny shrimps, and seahorses half the size of my little finger. I learned to dive in unexplored areas offshore from the many rivers that flow into the Gulf, where jungles of crimson, green, and brown seaweed sprouted from rocky limestone reefs. Under the canopy of golden forests of drifting sargassum, I swam with a floating zoo of small creatures: lacy brown sea slugs, juvenile jacks, and flying fish no larger than dragonflies.

Diving into the cool water of Ichetucknee, Weeki Wachee, Wakulla, and other inland springs, I glimpsed the honeycomb plumbing of underground tunnels, sinkholes, shafts, caves, and disappearing rivers that are common along the Gulf, all shaped from rock formed from the bodies of ancient sea creatures with calcium carbonate shells, skeletons, or cell walls. Bones of extinct mammals are there too—creatures that lived long before the arrival of humans. Ice ages have come and gone, with sea level high enough at times to drown most of the Yucatán and Florida, alternating with long stretches when both had more than double the dry land present today—changes that took place over millions of years.

Then, in mere decades, not millennia, the blue wilderness of my childhood disappeared: biologic change in the space of a lifetime.

By the mid-1950s manatees were already scarce, and monk seals, once common as far north as Galveston, were gone. By the end of the 20th century, up to 90 percent of the sharks, tuna, swordfish, marlins, groupers, turtles, whales, and many other large creatures that prospered in the Gulf for millions of years had been depleted by overfishing. The coral reefs had declined by half, and hundreds of miles of marshes, mangroves, and sea grass meadows were replaced by houses and hotels, malls and marinas. Rivers that once nourished the Gulf with vital nutrients now carried toxic loads of pollutants, forming massive “dead zones.”

## Mission Blue Partnership



In the face of urgent threats to the oceans, the **National Geographic Society**, **Waitt Family Foundation**, **Deep Search Foundation**, and National Geographic Explorer-in-Residence Sylvia Earle and National Geographic Fellow Enric Sala have joined ranks to establish Mission Blue, a new global initiative that seeks to restore the health and productivity of the seas. One of its signal goals will be to promote the creation of marine protected areas in critical ecosystems from the Poles to the tropics. Another aim will be to support solution-based research to reduce overfishing while considering the loss of marine-based livelihoods worldwide. “This effort is not only to inspire people to care about the oceans, but also to inspire people to act,” says Sala, who is a marine ecologist. “If we do something today, we know we’ll have an impact tomorrow.” To learn how to support this new campaign to save the seas, go to [ocean.nationalgeographic.com](http://ocean.nationalgeographic.com).

In 2003 I found reasons for hope in clear, deep water far offshore from the mouth of the Mississippi River. Through the transparent dome of a one-person sub, I watched pale blue deepen to shades of indigo as I descended into ebony darkness sparked with bioluminescence—living light generated by a glowing minestrone of thousands of small creatures startled by the sub’s passage. Nearing the bottom at 1,800 feet, I turned on the sub’s lights, illuminating a sofa-size tangle of pencil-thick tube worms, each creature a century or so old and crowned with a rosy fringe of tentacles. Their bodies were laced together with spaces large enough to shelter hundreds of translucent shrimps, dozens of pale crabs, several scorpionfish, and numerous red sea stars. Gas bubbled in a steady stream from the middle of the mass, a reminder that this thriving cold-water community was powered by chemosynthetic bacteria using methane, the organic remains of creatures that had lived in the sea 200 million years ago—not sunlight—as a source of energy. Clearly, life in this part of the Gulf was prospering.

Large areas of the Gulf have escaped being scraped by trawls, crushed by more than 40,000 miles of pipelines, or displaced by one of 50,000 oil and gas wells drilled since the middle of the 20th century. Some places have been deliberately protected. Waters around the Florida Keys and the northern Gulf’s Flower Garden Banks are sanctuaries. A network of protected reefs thrives off the coast of Veracruz, Mexico. Cuba also safeguards portions of its northern coast.

As a child, I did not know that people could consciously protect something as vast as the ocean nor that they could cause harm. But now we know: The ocean is in trouble, and therefore so are we. As biologist Edward O. Wilson has observed, “We are letting nature slip through our fingers, and taking ourselves along.” Smothered in an avalanche of oil and poisoned by toxic dispersants, the Gulf has become a sea of despair. Protecting vital sources of renewal—unscathed marshes, healthy reefs, and deep-sea gardens—will provide hope for the future of the Gulf, and for all of us. □

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*Sylvia Earle, author of *The World Is Blue: How Our Fate and the Ocean’s Are One*, has led more than 100 expeditions as part of her oceanographic research.*



Time for a Sea



**TOO MANY HOOKS IN THE WATER.** That's the problem with today's fisheries. Working from small pole-and-line boats to giant industrial trawlers, fishermen remove more than 170 billion pounds of wildlife a year from the seas. A new study suggests that our current appetite could soon lead to a worldwide fisheries collapse.



# Change

TUNA BOAT, SOLOMON ISLANDS  
JONATHAN CLAY



**BY PAUL GREENBERG**

Just before dawn a seafood summit convenes near Honolulu Harbor. As two dozen or so buyers enter the United Fishing Agency warehouse, they don winter parkas over their aloha shirts to blunt the chill of the refrigeration. They flip open their cell phones, dial their clients in Tokyo, Los Angeles, Honolulu—wherever expensive fish are eaten—and wait.

Soon the big freight doors on the seaward side of the warehouse slide open, and a parade of marine carcasses on pallets begins. Tuna as big around as wagon wheels. Spearfish and swordfish, their bills sawed off, their bodies lined up like dull gray I beams. Thick-lipped opah with eyes the size of hockey pucks rimmed with gold. They all take their places in the hall.

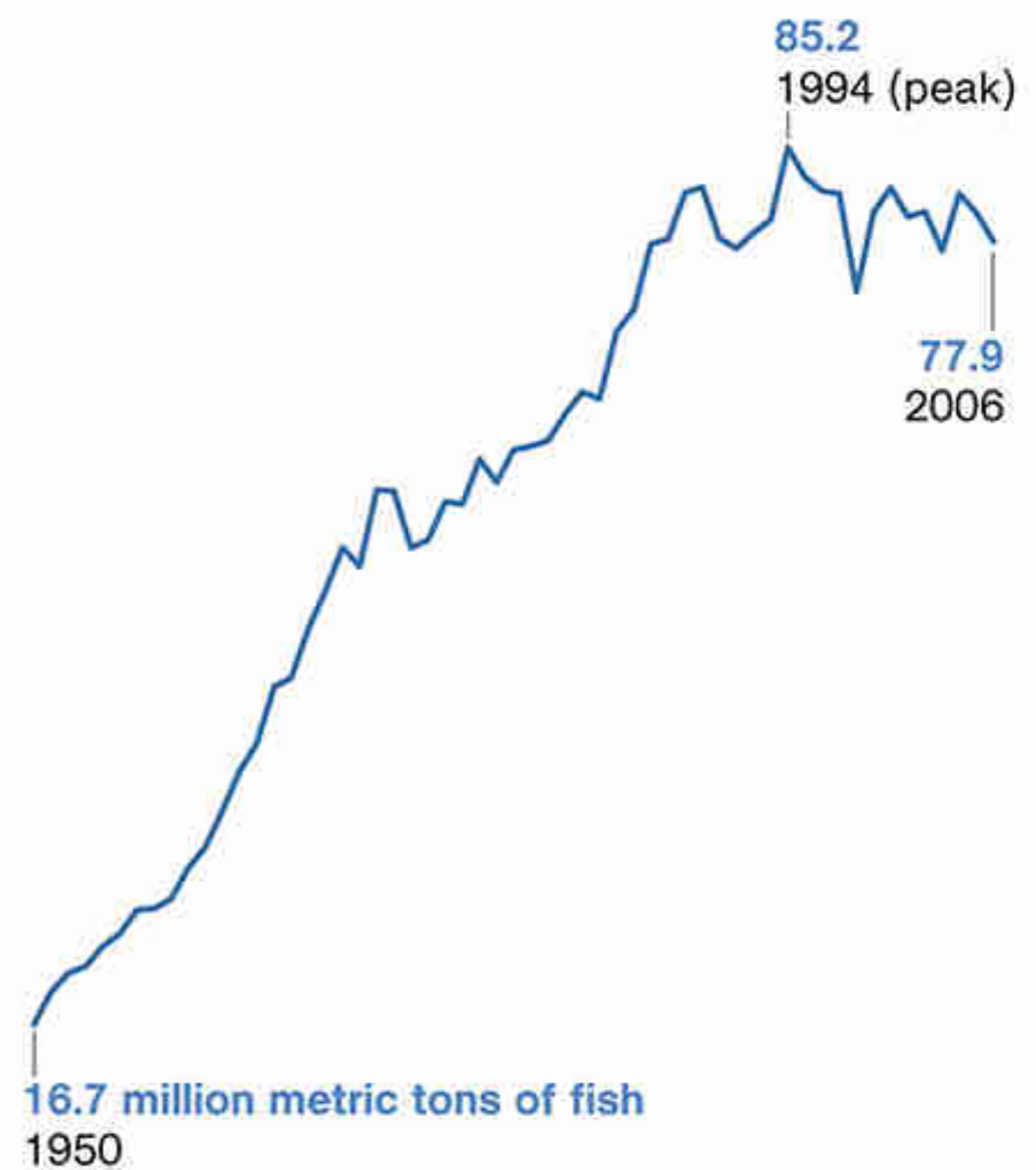
Auctioneers drill core samples from the fish and lay the ribbons of flesh on the lifeless white bellies. Buyers finger these samples, trying to divine quality from color, clarity, texture, and fat content. As instructions come in over cell phones, bids are conveyed to the auctioneer through mysterious hand gestures. Little sheets of paper with indecipherable scribbling are

slapped on a fish's flank when a sale is finalized. One by one fish are auctioned and sold to the highest bidder. In this way the marine wealth of the north-central Pacific is divided up among some of the world's most affluent purchasers.

Every year more than 170 billion pounds (77.9 million metric tons) of wild fish and shellfish are caught in the oceans—roughly three times the weight of every man, woman, and child in the United States. Fisheries managers call this overwhelming quantity of mass-hunted wildlife the world catch, and many maintain that this harvest has been relatively stable over the past decade. But an ongoing study conducted by Daniel Pauly, a fisheries scientist at the University of British Columbia, in conjunction with Enric Sala, a



Fish don't stand a chance nowadays. Factory ships like this Lithuanian trawler off Mauritania roam the world, hauling in massive amounts of fish and freezing the catch along the way.



### GLOBAL MARINE CAPTURE

During the past 50 years the annual world seafood catch has more than quadrupled, as fishing fleets have added new technologies and ventured into previously unexploited regions.

National Geographic fellow, suggests that the world catch is neither stable nor fairly divided among the nations of the world. In the study, called SeafoodPrint and supported by the Pew Charitable Trusts and National Geographic, the researchers point the way to what they believe must be done to save the seas.

They hope the study will start by correcting a common misperception. The public imagines a nation's impact on the sea in terms of the raw tonnage of fish it catches. But that turns out to give a skewed picture of its real impact, or seafood print, on marine life. "The problem is, every fish is different," says Pauly. "A pound of tuna represents roughly a hundred times the footprint of a pound of sardines."

The reason for this discrepancy is that tuna are apex predators, meaning that they feed at the very top of the food chain. The largest tuna eat enormous amounts of fish, including intermediate-level predators like mackerel, which in turn feed on fish like anchovies, which prey on microscopic copepods. A large tuna must eat the equivalent of its body weight every ten days

to stay alive, so a single thousand-pound tuna might need to eat as many as 15,000 smaller fish in a year. Such food chains are present throughout the world's ocean ecosystems, each with its own apex animal. Any large fish—a Pacific swordfish, an Atlantic mako shark, an Alaska king salmon, a Chilean sea bass—is likely to depend on several levels of a food chain.

To gain an accurate picture of how different nations have been using the resources of the sea, the SeafoodPrint researchers needed a way to compare all types of fish caught. They decided to do this by measuring the amount of "primary production"—those microscopic organisms at the bottom of the marine food web—required to make a pound of a given type of fish. They found that a pound of bluefin tuna, for example, might require a thousand pounds or more of primary production.

In assessing the true impact that nations have on the seas, the team needed to look not just at what a given nation caught but also at what the citizens of that nation ate. "A country can acquire primary production by fishing, or it can

# The Ocean Food Chain

LEVEL

4

## TOP PREDATORS

Slow to reproduce, these fish are among the most energy demanding in the sea.



### ATLANTIC BLUEFIN TUNA

Because overfishing has cut the population of this fish to a fraction of its original abundance, conservationists urge a fishing moratorium.

### ORANGE ROUGHY

The orange roughy fishery in the Southern Hemisphere was heavily exploited in the 1980s. The largest of these deep-sea fish live a century or more.



### ATLANTIC SALMON

Most Atlantic salmon sold in the U.S. come from aquaculture operations, where they are fed fish meal, adding to the pressures on wild fish.

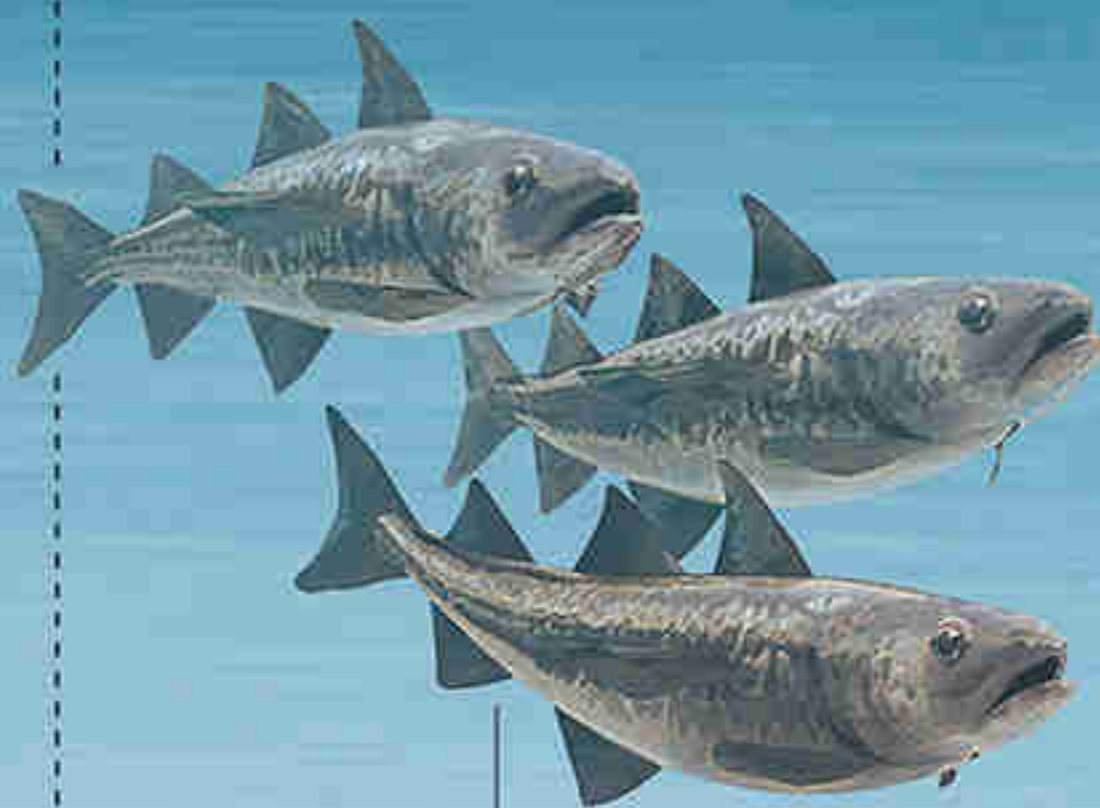


LEVEL

3

## INTERMEDIATE PREDATORS

These species are vital for keeping lower-level fish populations in check.



### ALASKA POLLOCK

Although its biomass has declined in recent years, this species (often sold as fish sticks) remains the largest U.S. fishery by volume.



### ATLANTIC HERRING

Important prey for seabirds, ocean mammals, and other fish, the Atlantic herring was overfished in the 1960s but is now recovering.



### JAPANESE FLYING SQUID

Preyed upon by albatrosses and sperm whales, the Japanese flying squid lives only a year or so but can replenish its population quickly.



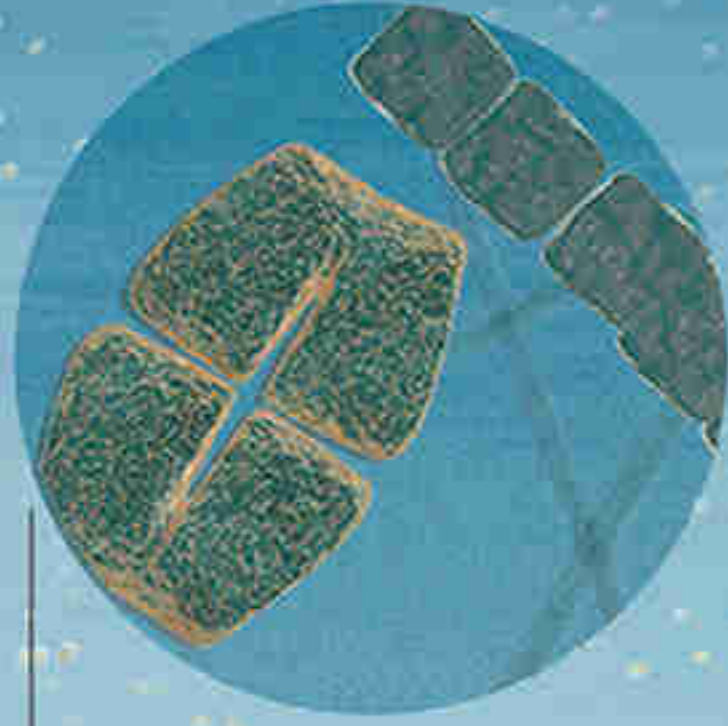
Phytoplankton and algae drive ocean ecosystems. They capture solar energy through photosynthesis and, when eaten by zooplankton, transfer that energy up the food chain. Small fish eat zooplankton and in turn are eaten by big fish, which are targeted by fishermen.

LEVEL

2

### FIRST-ORDER CONSUMERS

Able to reproduce quickly, these species account for much of the ocean biomass.



#### ZOOPLANKTON

These tiny animals feed on phytoplankton and are eaten by fish and baleen whales.

LEVEL

1

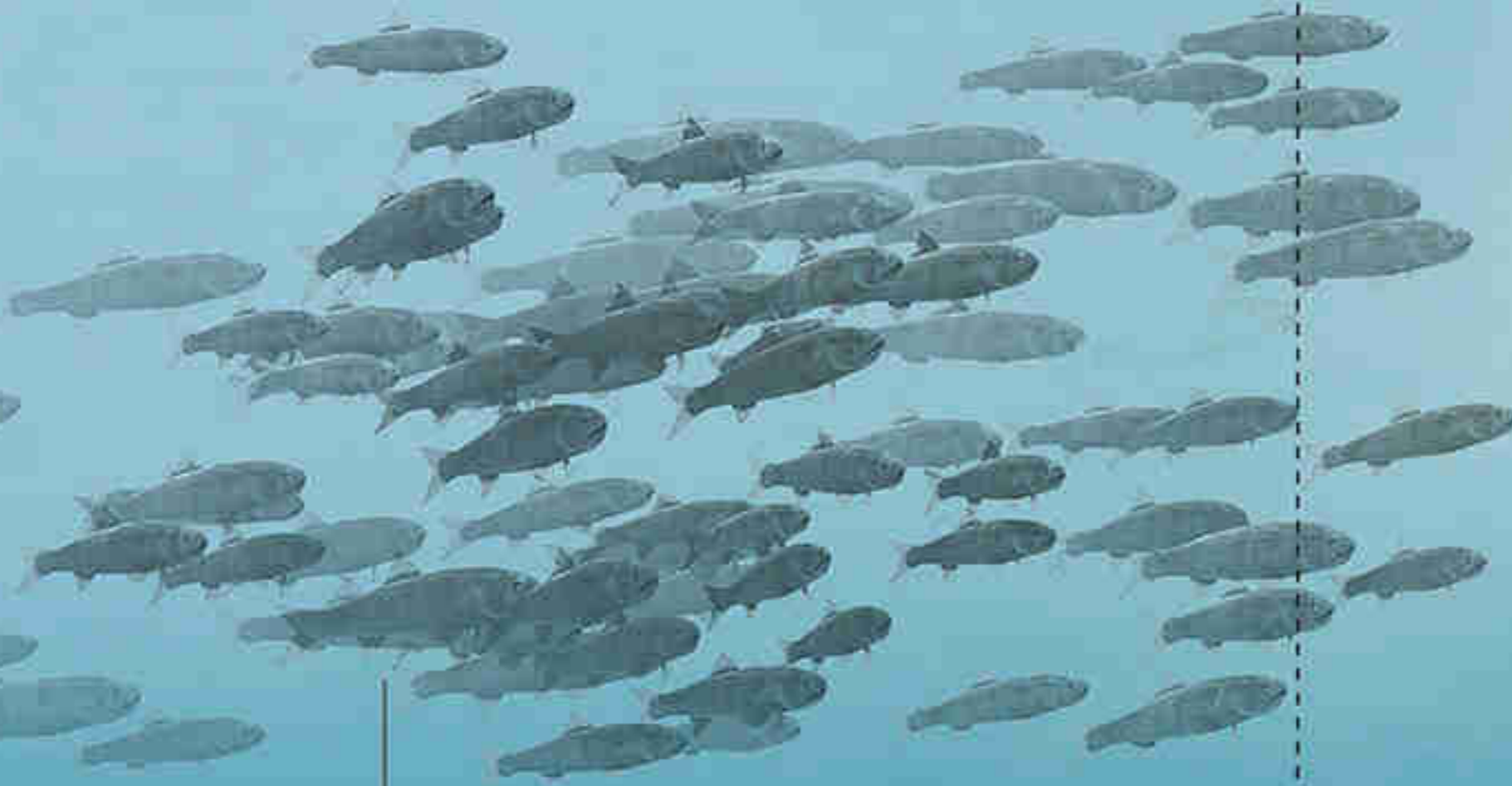
### PRIMARY PRODUCERS

Organisms at the lowest level capture solar energy through photosynthesis.



#### PHYTOPLANKTON

Microscopic, plantlike organisms are so abundant in the sea that they are responsible for half of Earth's photosynthesis.



#### PERUVIAN ANCHOVETA

The world's largest fishery by volume, anchoveta are often ground up for animal feed. El Niño events drive big ups and downs in their populations.

#### AMERICAN LOBSTER

Since the population of its main predator, cod, was overfished and collapsed, the American lobster has rebounded.



#### ALGAE

Popular as food around the world, red algae seaweed species need only water and light to thrive.



MARIEL FURLONG, NGM STAFF, AND ALEJANDRO TUMAS  
ART: HERNAN CAÑELLAS

SOURCES: ENRIC SALA; SEA AROUND US PROJECT,  
UNIVERSITY OF BRITISH COLUMBIA FISHERIES CENTRE;  
BARTON SEAVER

# What We Eat Makes a Difference

LEVEL  
**4**

## TOP PREDATORS

When you eat

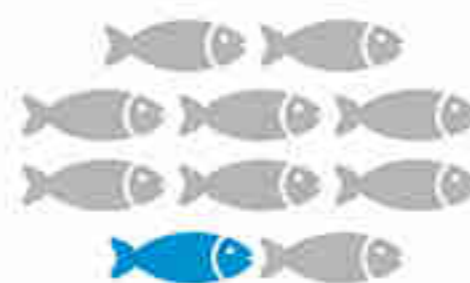
**1 pound**  
of a level 4 fish,  
it's like eating ...



LEVEL  
**3**

## INTERMEDIATE PREDATORS

**10 pounds** of level 3 fish



But if you consume

**1 pound**  
of level 3 fish,  
it's like eating ...

acquire it by trade," Pauly says. "It is the sheer power of wealthy nations to acquire primary production that is important."

Nations with money tend to buy a lot of fish, and a lot of the fish they buy are large apex predators like tuna. Japan catches less than five million metric tons of fish a year, a 29 percent drop from 1996 to 2006. But Japan consumes nine million metric tons a year, about 582 million metric tons in primary-production terms. Though the average Chinese consumer generally eats smaller fish than the average Japanese consumer does, China's massive population gives it the world's biggest seafood print, 694 million metric tons of primary production. The U.S., with both a large population and a tendency to eat apex fish, comes in third: 348.5 million metric tons of primary production. And the size of each of these nations' seafood prints is growing. What the study points to, Pauly argues, is that these quantities are not just extremely

large but also fundamentally unsustainable.

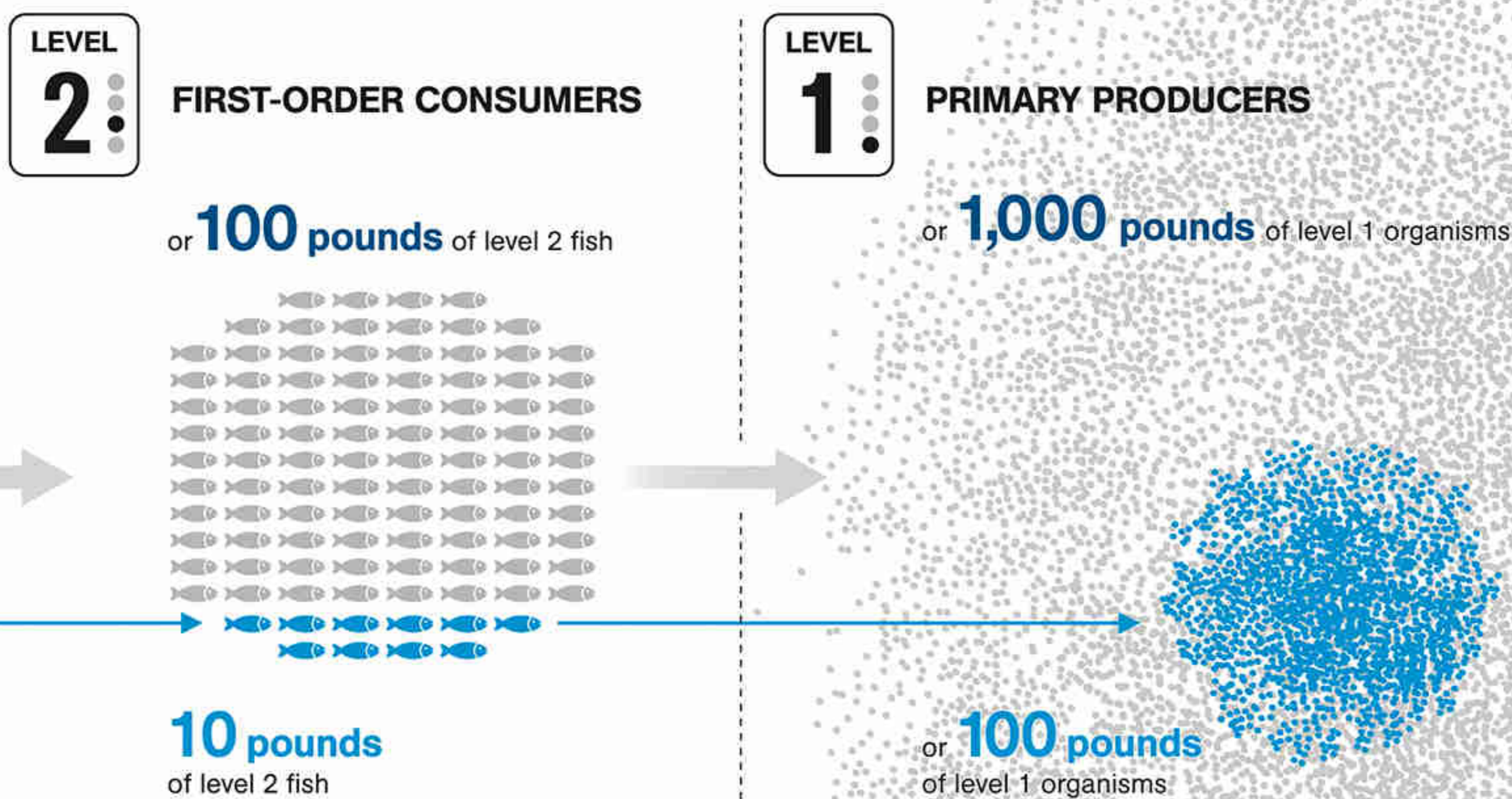
Exactly how unsustainable can be seen in global analyses of seafood trade compiled by Wilf Swartz, an economist working on Seafood-Print. As the maps on page 86 show, humanity's consumption of the ocean's primary production changed dramatically from the 1950s to the early 2000s. In the 1950s much less of the ocean was being fished to meet our needs. But as affluent nations increasingly demanded apex predators, they exceeded the primary-production capacities of their exclusive economic zones, which extend up to 200 nautical miles from their coasts. As a result, more and more of the world's oceans had to be fished to keep supplies constant or growing.

Areas outside of these zones are known in nautical parlance as the high seas. These vast territories, the last global commons on Earth, are technically owned by nobody and everybody. The catch from high-seas areas has risen to nearly ten times what it was in 1950, from 1.6 million metric tons to around 13 million metric tons. A large part of that catch is high-level, high-value tuna, with its huge seafood print.

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*Paul Greenberg is the author of Four Fish: The Future of the Last Wild Food.*

A top predator requires exponentially more energy to survive than does a fish at a lower level of the food chain. When wealthy nations catch or buy top predators, they increase their impact on the ocean compared with poor nations, which tend to eat smaller fish.



The wealthier nations that purchase most of the products of these fisheries are essentially privatizing them. Poorer countries simply cannot afford to bid for high-value species. Citizens in these nations can also lose out if their governments enter into fishing or trade agreements with wealthier nations. In these agreements local fish are sold abroad and denied to local citizens—those who arguably have the greatest need to eat them and the greatest right to claim them.

Although supermarkets in developed nations like the U.S. and Japan still abound with fish flesh, SeafoodPrint suggests that this abundance is largely illusory because it depends on these two troubling phenomena: broader and broader swaths of the high seas transformed from fallow commons into heavily exploited, monopolized fishing grounds; and poor nations' seafood wealth spirited away by the highest bidder.

Humanity's demand for seafood has now driven fishing fleets into every virgin fishing ground in the world. There are no new grounds left to exploit. But even this isn't enough. An unprecedented buildup of fishing capacity threatens to

outstrip seafood supplies in all fishing grounds, old and new. A report by the World Bank and the Food and Agriculture Organization (FAO) of the United Nations recently concluded that the ocean doesn't have nearly enough fish left to support the current onslaught. Indeed, the report suggests that even if we had half as many boats, hooks, and nets as we do now, we would still end up catching too many fish.

Some scientists, looking at the same data, see a different picture than Daniel Pauly does. Ray Hilborn, a fisheries scientist at the University of Washington, doesn't think the situation is so dire. "Daniel is fond of showing a graph that suggests that 60 to 70 percent of the world's fish stocks are overexploited or collapsed," he says. "The FAO's analysis and independent work I have done suggests that the number is more like 30 percent." Increased pressure on seafood shouldn't come as a surprise, he adds, since the goal of the global fishing industry is to fully exploit fish populations, though without damaging their long-term viability.

Many nations, meanwhile, are trying to

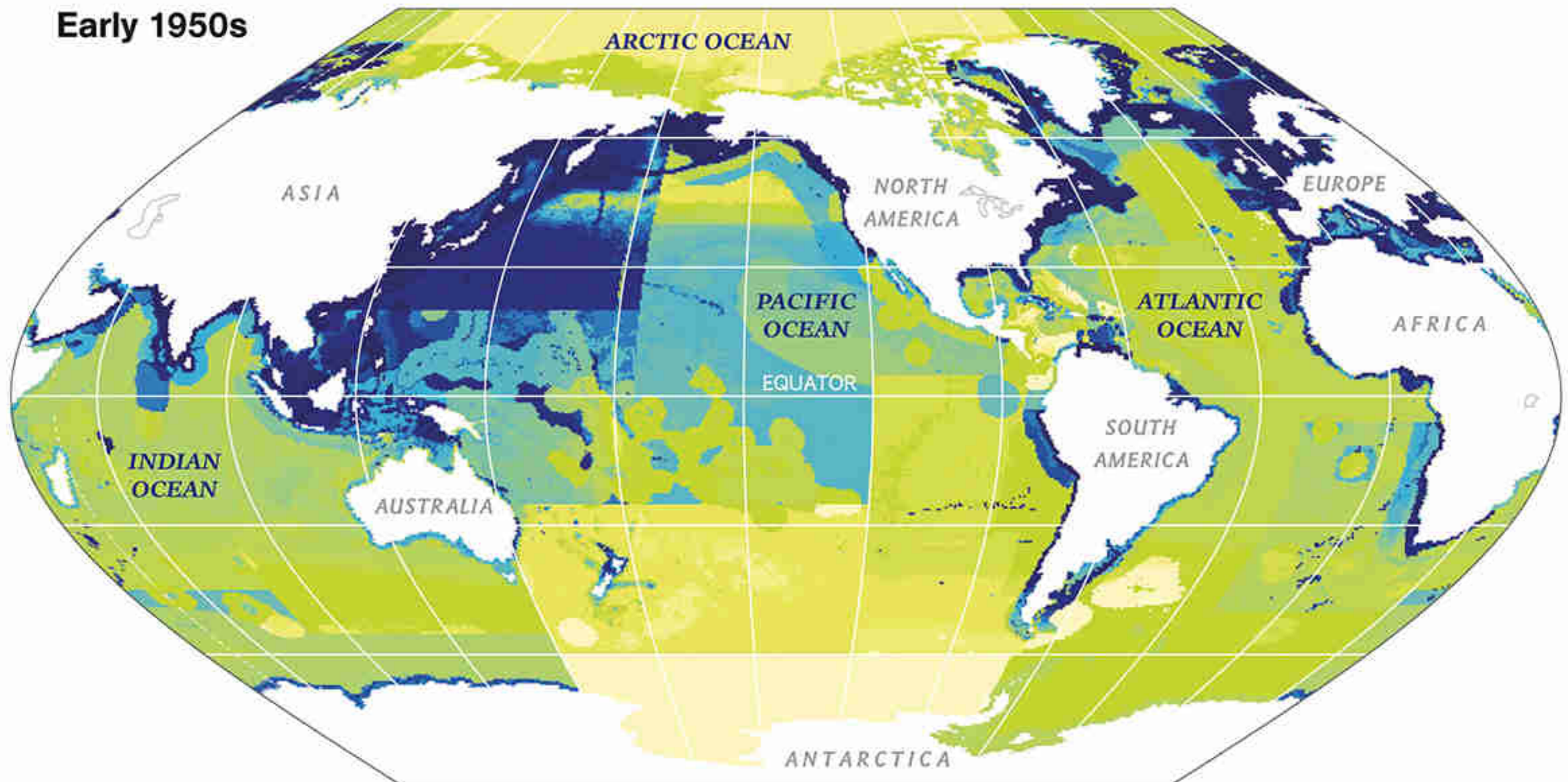
# Where Fish Are Caught

The opening of new fishing grounds during the past half century has caused a boom in the world catch, as fleets with increased range and capacity have spread out across the open seas. Now the consequences of overfishing are apparent in every ocean.

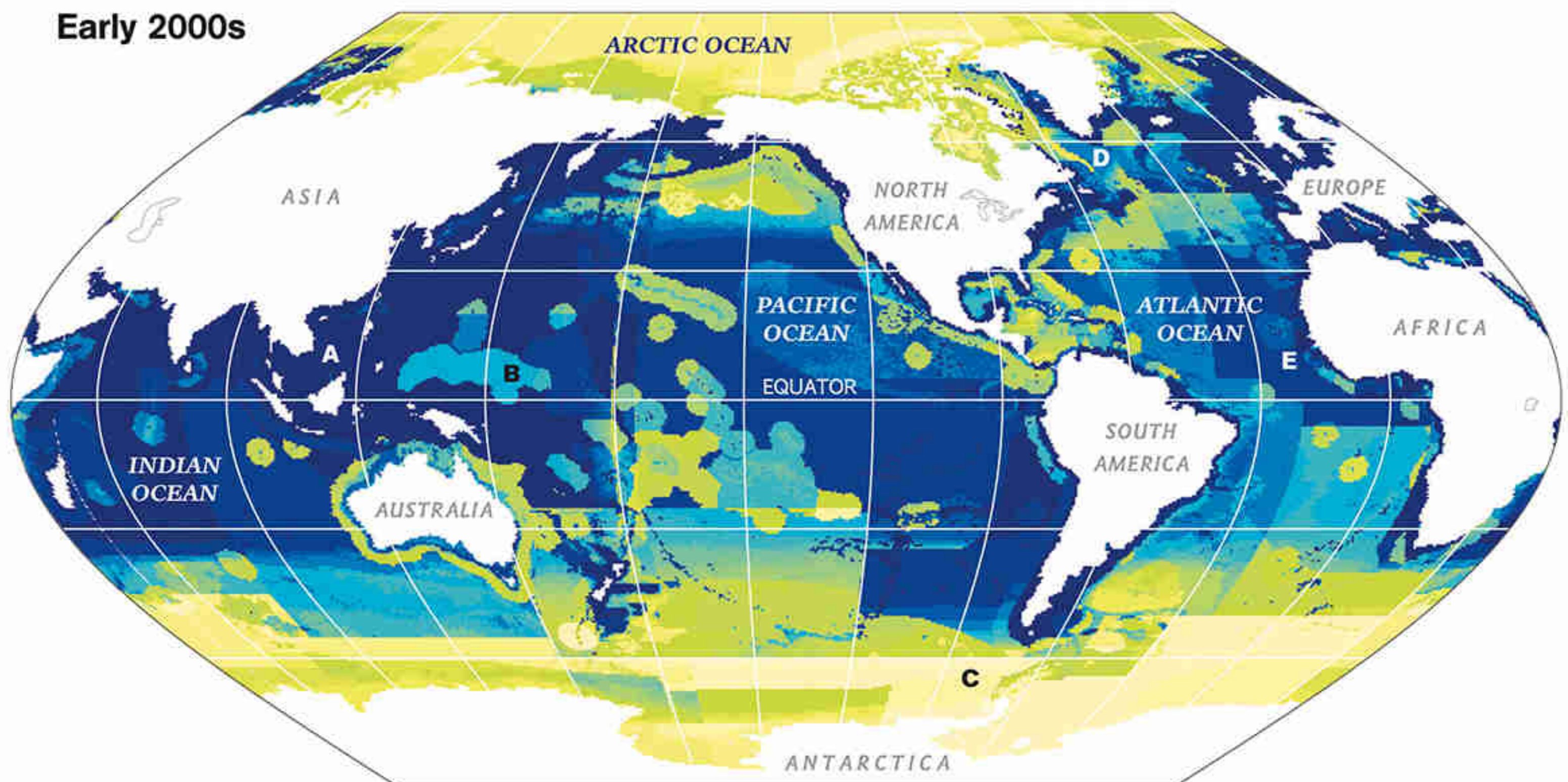
LOW  HIGH

Harvest intensity: ocean catch by half-degree cell (930 sq mi; 2,410 sq km), expressed in terms of primary production (metric tons of phytoplankton) over a five-year period

## Early 1950s



## Early 2000s



### HARVESTING PATTERNS

**A: Southeast Asia**  
The popularity of sushi has taken a toll on tuna stocks. Several species are showing signs of decline.

**B: Exclusive economic zones** Created in 1982, the zones have slowed the growth of fisheries within 200 nautical miles of nations' coasts.

**C: Global south**  
After fleets moved into waters around Antarctica, Chilean sea bass stocks were quickly depleted.

**D: North Atlantic**  
A thousand years of fishing by everyone from Vikings to modern Spaniards has driven cod to near collapse.

**E: Eastern Atlantic**  
European fleets have targeted Africa's coasts. Leaders selling fishing rights may ignore costs to local food supplies.



# Who Catches and Who Consumes

Wealthy nations once obtained most of their fish by fishing. Today they're more likely to buy a swordfish than to catch it. Japan purchases more than twice as much fish as it catches, while Peruvians, the number two seafood producers in the world, consume barely any at all.

## Catch: Top 20

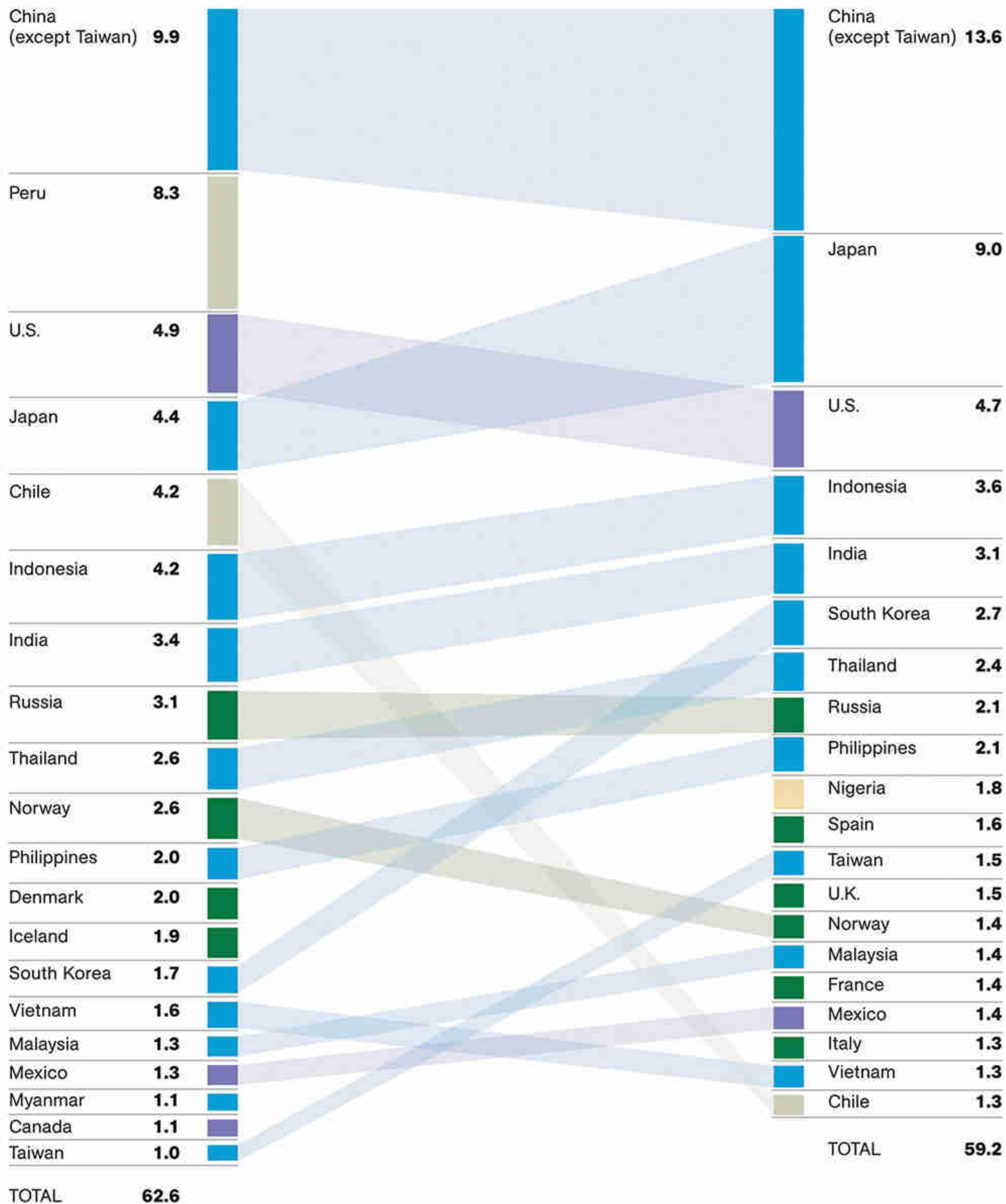
LANDINGS  
(MILLION METRIC TONS OF FISH)

Annual average 2001-05

ASIA N. AMERICA EUROPE  
AFRICA S. AMERICA

## Consumption: Top 20

LANDINGS  
(MILLION METRIC TONS OF FISH)



### TOTAL CONSUMPTION

Annual average 2001-05

Not all of the fish that are caught are eaten. A third of today's catch is used for industrial purposes, such as the manufacturing of paints and cosmetics or feed for farm-raised salmon, tuna, and even pigs and chickens.

MAPS: MARTIN GAMACHE, NGM STAFF  
CHARTS: MARIEL FURLONG, NGM STAFF, AND ALEJANDRO TUMAS  
SOURCE: SEA AROUND US PROJECT, UNIVERSITY OF BRITISH COLUMBIA FISHERIES CENTRE



compensate for the world's growing seafood deficit by farming or ranching high-level predators such as salmon and tuna, which helps maintain the illusion of abundance in the marketplace. But there's a big problem with that approach: Nearly all farmed fish consume meal and oil derived from smaller fish. This is another way that SeafoodPrint might prove useful. If researchers can tabulate the ecological value of wild fish consumed on fish farms, they could eventually show the true impact of aquaculture.

Given such tools, policymakers might be in a better position to establish who is taking what from the sea and whether that is just and sustainable. As a global study, SeafoodPrint makes clear that rich nations have grossly underestimated their impacts. If that doesn't change, the abundance of fish in our markets could drop

off quickly. Most likely the wealthy could still enjoy salmon and tuna and swordfish. But middle-class fish-eaters might find their seafood options considerably diminished, if not eliminated altogether.

What then is SeafoodPrint's long-range potential? Could some version of it guide a conservation agreement in which nations are given a global allowance of oceanic primary production and fined or forced to mend their ways if they exceed it?

"That would be nice, wouldn't it?" Pauly says. He points out that we already know several ways to shrink our impact on the seas: reduce the world's fishing fleets by 50 percent, establish large no-catch zones, limit the use of wild fish as feed in fish-farming. Unfortunately, the seafood industry has often blocked the road to reform.



## **Demand for seafood has now driven fishing fleets into every virgin fishing ground in the world. There are no new grounds left to exploit.**

### **EMPTY SEA, FULL MARKET**

Hundreds to thousands of pounds of salmon move through Seattle's Pike Place Market each day, much of it caught in Alaska's well-managed waters. While affluent nations may practice good fisheries management at home, they often rely on poorly monitored developing countries for much of their seafood. The result could be empty fish markets in the poorest places.

SeafoodPrint could also give consumers a map around that roadblock—a way to plot the course toward healthy, abundant oceans. Today there are dozens of sustainable-seafood campaigns, each of which offers suggestions for eating lower on the marine food chain. These include buying farmed tilapia instead of farmed salmon, because tilapia are largely herbivorous and eat less fish meal when farmed; choosing trap-caught black cod over long-lined Chilean sea bass, because fewer unwanted fish are killed in the process of the harvest; and avoiding eating giant predators like Atlantic bluefin tuna altogether, because their numbers are simply too low to allow any harvest at all.

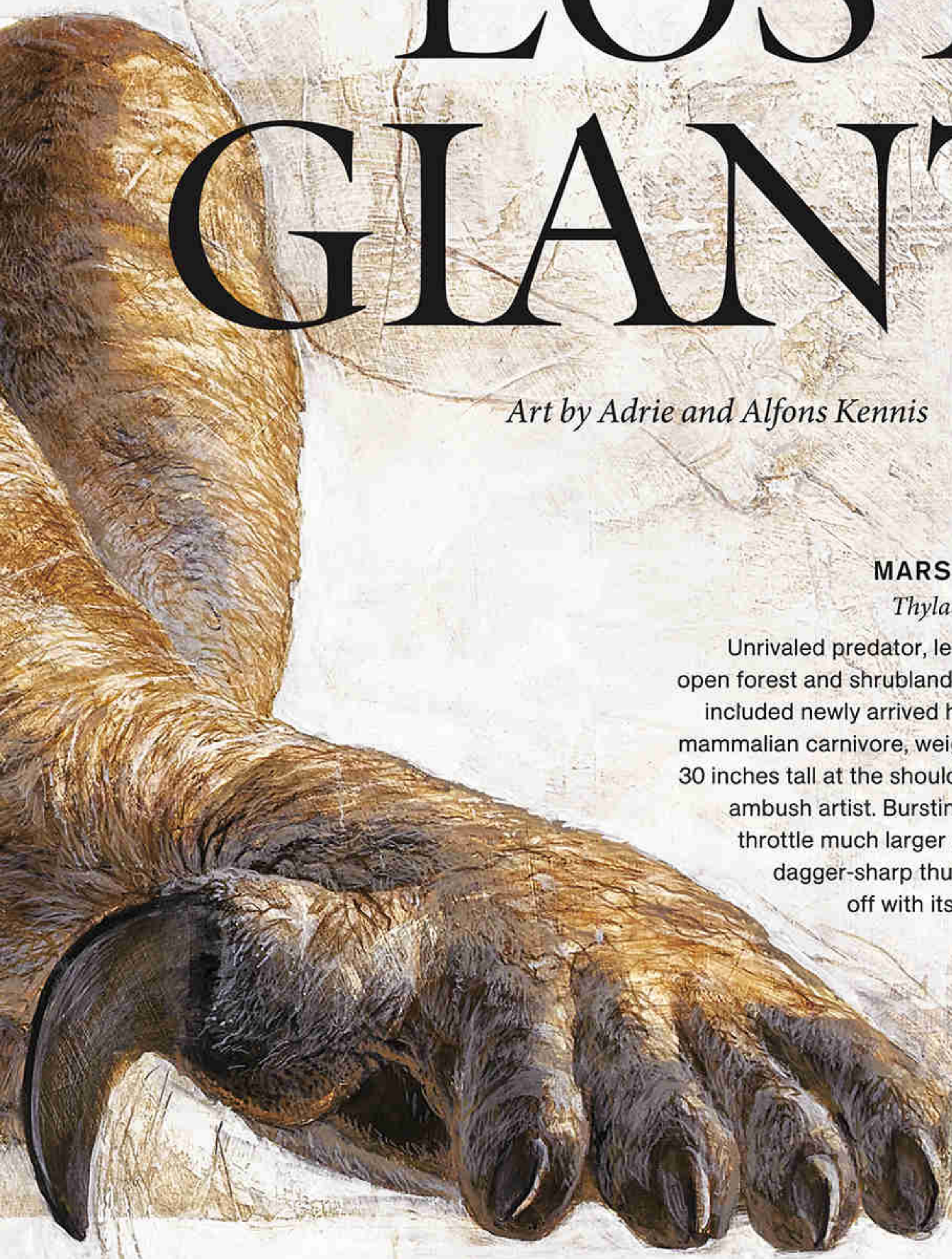
The problem, say conservationists, is that the oceans have reached a critical point. Simply changing our diets is no longer sufficient if fish

are to recover and multiply in the years ahead. What Pauly and other conservation biologists now believe is that suggestions must be transformed into obligations. If treaties can establish seafood-consumption targets for every nation, they argue, citizens could hold their governments responsible for meeting those targets. Comparable strategies have worked to great effect in terrestrial ecosystems, for trade items such as furs or ivory. The ocean deserves a similar effort, they say.

“Barely one percent of the ocean is now protected, compared with 12 percent of the land,” Enric Sala adds, “and only a fraction of that is fully protected.” That’s why National Geographic is partnering with governments, businesses, conservation organizations, and citizens to promote marine reserves and help reduce the impact of fishing around the globe.

In the end, neither Pauly nor Sala nor the rest of the SeafoodPrint team wants to destroy the fishing industry, eliminate aquaculture, or ban fish eating. What they do want to change is business as usual. They want to let people know that today’s fishing and fish-farming practices are not sustainable and that the people who advocate maintaining the status quo are failing to consider the ecological and economic ramifications. By accurately measuring the impacts nations have on the sea, SeafoodPrint may lay the groundwork for effective change, making possible the rebuilding of the ocean’s dwindling wealth. Such a course, Pauly believes, could give the nations of the world the capability, in the not too distant future, to equitably share a truly bountiful, resurrected ocean, rather than greedily fight over the scraps that remain in the wake of a collapse. □





Seven-foot-tall kangaroos, rhino-size browsers, enormous flightless birds, and a predator that could kill them all: Such were the megafauna that once dominated Australia. Then humans arrived, and most of the giant animals vanished. Did the Ice Age finally catch up with them? Or did humans hunt megafauna to extinction?

# LOST GIANTS

*Art by Adrie and Alfons Kennis*

## **MARSUPIAL LION**

*Thylacoleo carnifex*

Unrivaled predator, leopard-size *T. carnifex* stalked open forest and shrubland in search of prey, which probably included newly arrived humans. The continent's largest mammalian carnivore, weighing up to 350 pounds and up to 30 inches tall at the shoulder, this hunter likely thrived as an ambush artist. Bursting from undergrowth, it could throttle much larger game, grasping its prey with dagger-sharp thumb claws and finishing it off with its large front teeth.





Giant wallabies bounded through the grass. Short-faced kangaroos pulled down eucalyptus leaves. Hunters with spears hid behind tussocks. The prehistoric megafauna landscape survives in Cradle Mountain–Lake St. Clair National Park in Tasmania.

*By Joel Achenbach*

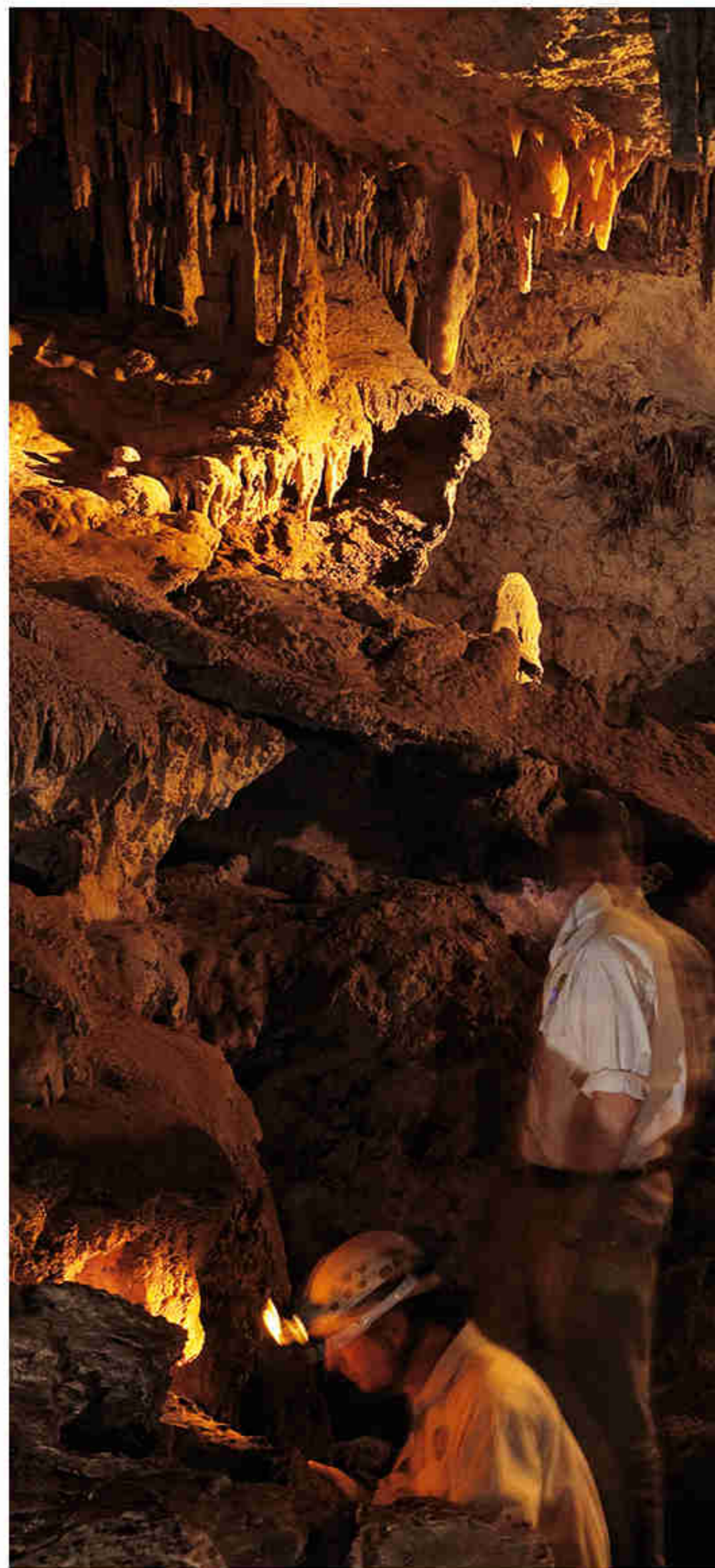
*Photographs by Amy Toensing*

## **YOU WILL FIND THE NARACOORTE CAVES IN THE PASTORAL WINE COUNTRY OF SOUTH AUSTRALIA,**

four hours from Adelaide on lonely roads heading toward what the Aussies call the Southern Ocean. The grapevines thrive in red soil that sits like a layer of icing on porous limestone. It's lovely country, but it can be treacherous. The ground is pocked with holes, many no wider than a café table, known as pitfall traps. They're deep. They plunge into the blackest of caverns. Pitfall traps have gobbled up many a kangaroo bounding through the night.

One day in 1969 a fledgling fossil hunter named Rod Wells came to Naracoorte to explore what was then known as Victoria Cave. It was an old tourist attraction, with steps and handrails and electric lights. But Wells and half a dozen colleagues ventured beyond the tourist section, clawing through dark, narrow passages. When they felt a suggestive breeze wafting from a pile of loose rubble, they knew there was a chamber beyond. Wells and one other slithered into the huge room. Its expansive floor of red soil was littered with strange objects. It took Wells a moment to realize what they were looking at. Bones: lots of bones. Pitfall-trap victims galore.

Victoria Fossil Cave, as the cavern is now known, warehouses the bones of something like 45,000 animals. Some of the oldest bones belonged to creatures far larger and more fearsome than any found today in Australia. They were the ancient Australian megafauna—huge animals that roamed the continent during the Pleistocene epoch.



In boneyards across the continent, scientists have found the fossils of a giant snake; a huge flightless bird; a wombat-like creature the size of a rhinoceros; and a seven-foot-tall kangaroo with a strangely short face. They've found the remains of a tapir-like creature; a hippo-like beast; and a lizard, 20 feet long, that ambushed its prey and swallowed everything down to the last feather.

The Australian megafauna dominated their ecosystems—and then were gone in an extinction spasm that swept away nearly every animal that weighed a hundred pounds or more. What, exactly, killed them off?





Park guides scout bone-rich sediment in Kelly Hill Caves on Kangaroo Island, possibly one of the last places megafauna survived in Australia. Scientists are finding abundant remains of animals that fell into the caves.

Given how much ink has been spilled on the extinction of the dinosaurs, it's a wonder that even more hasn't been devoted to the megafauna of the Pleistocene, creatures that had the dual virtues of being dramatically large *and* coexistent with humans. Prehistoric humans never threw spears at *Tyrannosaurus rex*, except

in cartoons. Humans, however, really did hunt mammoths and mastodons.

The disappearance of American megafauna—mammoth, camels, giant short-faced bears, giant armadillos, stag moose, glyptodonts, saber-toothed cats, dire wolves, giant ground sloths, and horses, among others—happened relatively soon after the arrival of human beings, about 13,000 years ago. In the 1960s, paleoecologist Paul Martin developed what became known as the blitzkrieg hypothesis. Modern humans, Martin said, created havoc as they spread through the Americas, wielding spears tipped with stone points to annihilate animals that had never

faced a technological predator. But the extinction spasm wasn't comprehensive. North America kept its deer, pronghorn, black bears, and a small type of bison; brown bears and newly arrived elk and moose expanded their ranges. South America retained jaguars and llamas.

In Australia the largest indigenous land animals are red kangaroos.

What happened to Australia's large animals is one of the planet's most baffling paleontological mysteries. For years scientists blamed the extinctions on climate change. Indeed, Australia has been drying out for a million years or more, and the megafauna were faced with a continent that became increasingly parched and denuded of vegetation. Australian paleontologist Tim Flannery suggests that humans, who arrived on

## HOW COULD PEOPLE ARMED WITH ONLY SPEARS AND FIRE HAVE ERADICATED SO MANY SPECIES? BY DEFINITION, IN EXTINCTION THERE CAN BE NO SURVIVORS.

the continent around 50,000 years ago, used fire to hunt, which led to deforestation and a dramatic disruption of the hydrologic cycle.

Here's what's certain, Flannery says. Something dramatic happened to Australia's dominant land creatures—abruptly (how abruptly is a matter of debate)—somewhere around 46,000 years ago, strikingly soon after the invasion of a tool-wielding, highly intelligent predator.

In 1994 Flannery published a book called *The Future Eaters*, in which he advanced the antipodal version of Paul Martin's blitzkrieg hypothesis. He put forth an even broader and more ambitious thesis as well: that human beings, in general, are a new kind of animal on the planet,

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*Joel Achenbach is reporting on the Gulf oil spill for the Washington Post. Amy Toensing covered the drought in Australia's Murray-Darling River Basin in April 2009. Dutch twin brothers and artists, Adrie and Alfons Kennis specialize in paintings and models of extinct animals and humans.*

one prone to ruining ecosystems and destroying their own futures.

Flannery's book proved highly controversial. Some viewed it as critical of the Aborigines, who pride themselves on living in harmony with nature. The more basic problem with Flannery's thesis is that there is no direct evidence that human beings killed any of the megafauna—not so much as a single animal. It would be helpful if someone uncovered a *Diprotodon* skeleton with a spear point embedded in a rib—or perhaps a pile of *Thylacoleo* bones next to the charcoal of a human campfire. Such kill sites have been found in the Americas. But there's no archaeological analog in Australia. As one of Flannery's most prominent critics, Stephen Wroe of the University of New South Wales, puts it, "If this

were a murder trial, it wouldn't get past first base. It would be laughed out of court."

Another challenge to the Flannery model of Australian megafauna extinction is

more mechanistic: How could people armed with only spears and fire have eradicated so many species? Relatively few people, maybe numbering in just the thousands, would have had to kill a population of animals dispersed in a wide variety of habitats and refuges across an entire continent. Extinction is different: By definition there can be no survivors.

THE DEBATE ABOUT megafauna pivots to a great degree on the techniques for dating old bones and the sediments in which they are buried. It's all about timing. If scientists can show that the megafauna died out fairly quickly and that this extinction event happened within a few hundred years, or even a couple thousand years, of the arrival of humans, that's a strong case—even if a purely circumstantial one—that the one thing was the direct result of the other. Flannery contends that islands hold another clue to the mystery. Some species of megafauna survived on Tasmania until 40,000 (Continued on page 105)



## GIANT SHORT-FACED KANGAROO

*Procoptodon goliah*

No living kangaroo can do this: reach above its head and pull leaves off a tree. Long, clawed fingers and forelimbs that could extend upward like human arms allowed *P. goliah*, the largest kangaroo ever, to thrive as a browser in open forests. The seven-foot-tall marsupial with hooflike toes was one of the last of the megafauna to go extinct, overlapping with humans for thousands of years and likely inspiring Aboriginal tales about a long-limbed fighting roo.

# THE MYSTERY OF MEGAFAUNA EXTINCTIONS

Between 50,000 and 10,000 years ago, two-thirds of all large animal genera in the world, from mastodons to giant kangaroos, disappeared. Was climate change, with shifts in rainfall patterns and vegetation, responsible for the die-off of megafauna (large-bodied animals weighing about a hundred pounds or more)? Or, as mounting evidence suggests, did the fanning out of humans from Africa and Asia—a new, sophisticated predator—contribute to rapid, continent-wide extinctions?

Approximate extinction dates\*

70,000 YEARS AGO (Y.A.)                      60,000                      50,000                      40,000

## Australia

Extinction of a majority of megafauna genera appears to coincide with human settlement over a 5,000-year period. Contributing factors included hunting and changes in vegetation caused by fire and a falling population of giant herbivores.

Humans arrive about 50,000 years ago.



## North and South America

North America once harbored an array of large mammal species rivaling Africa's. Within a few millennia of a major influx of hunters from Siberia about 13,000 years ago, most megafauna in North and South America were gone.

N. America

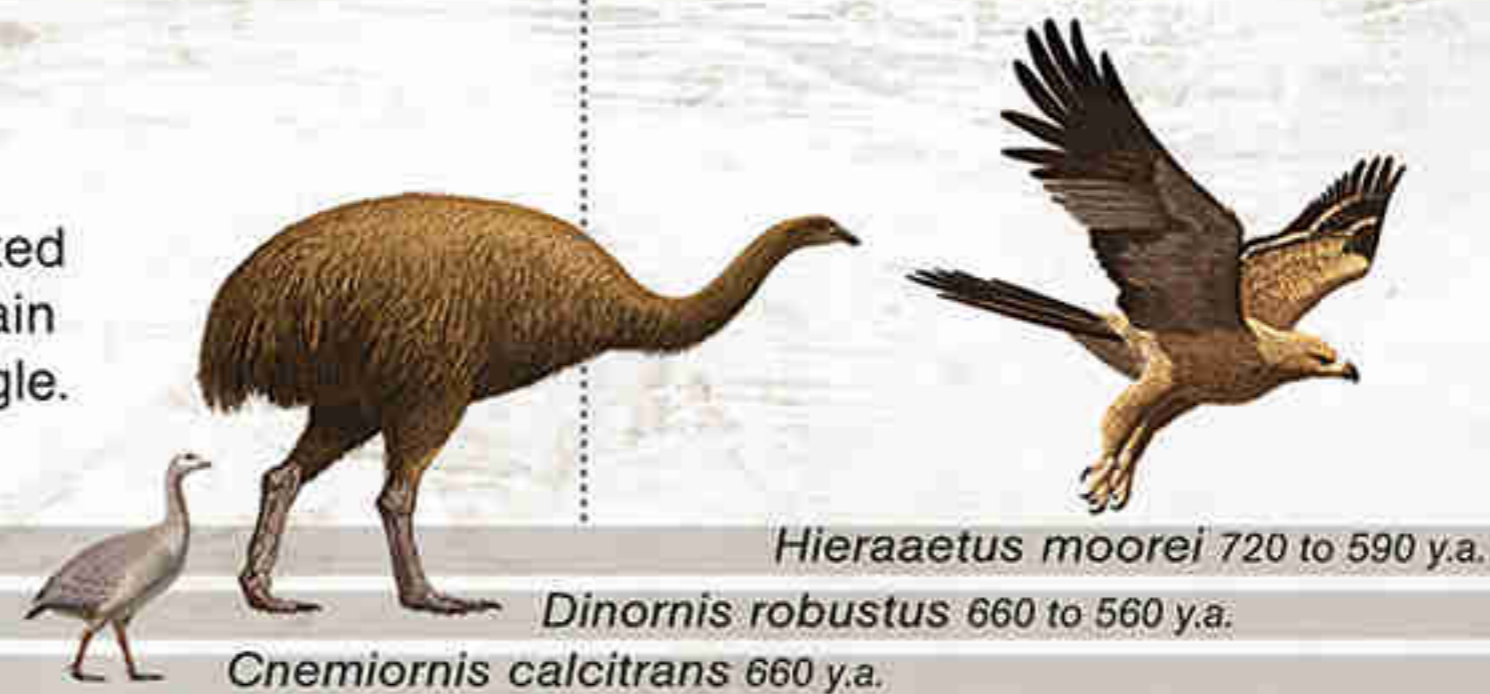


S. America



## New Zealand

A century or so after the arrival of Polynesians, who became the Maori, hunting and land clearing eliminated giant birds, most notably the wingless moa and its main predator, Haast's eagle, the world's largest known eagle.



70,000 YEARS AGO

60,000

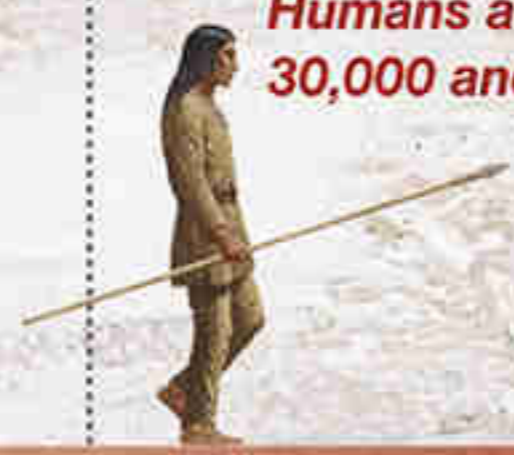
50,000

40,000



*Thylacinus cynocephalus* 74 y.a.

The striped Tasmanian tiger, a dog-size marsupial, survived until the early 20th century on Tasmania.



Humans arrive between 30,000 and 13,000 years ago.

Humans first settle about 700 years ago.



30,000 20,000 10,000 TODAY

SOURCES: ANTHONY D. BARNOSKY, UNIVERSITY OF CALIFORNIA, BERKELEY; AARON CAMENS, UNIVERSITY OF ADELAIDE; ARAPATA HAKIWA, MUSEUM OF NEW ZEALAND; RICHARD N. HOLDAWAY, PALAECOL RESEARCH LTD; JOHN A. LONG, NATURAL HISTORY MUSEUM OF LOS ANGELES COUNTY; DENNIS STANFORD AND HANS-DIETER SUES, NATIONAL MUSEUM OF NATURAL HISTORY; ROD T. WELLS, FLINDERS UNIVERSITY



## STIRTON'S THUNDERBIRD

*Dromornis stirtoni*

Perhaps the largest known bird, *D. stirtoni* never left the ground. Ten feet tall and weighing a thousand pounds, it belonged to a family of giant flightless birds, the dromornithids. Parrotlike beaks could crack fruit and nuts. Humans never saw Stirton's thunderbird; it lived about eight million years ago in the late Miocene, when Australia was drying out. Smaller, less specialized species, such as *Genyornis newtoni*, lasted into the Pleistocene. Though emu-like in shape, dromornithids are related to ducks and geese:

## MARSUPIAL TAPIR

*Palorchestes painei*

"Tree wreckers": that's how paleontologist Tim Flannery describes *Palorchestes*, cow-size marsupials that used powerful limbs, a trunk-like nose, and a long giraffe-type tongue to strip bark and tear up roots. Scientists first mistook their teeth for those of giant kangaroos, hence the name, meaning "ancient leapers." The snout is tapir-like, but wombats and koalas are their closest kin. A changing climate long before human arrival probably doomed *Palorchestes painei*, which gave way in the Pleistocene to *Palorchestes azael*, better suited to dryland vegetation.



A photograph taken from a dark, textured overhang, looking out over a vast landscape. The foreground is a dark, almost black, textured surface. A thin, light-colored strip of ground or rock runs along the edge of the overhang. Beyond this, a bright blue sea stretches to the horizon. In the distance, there are low, hilly landmasses under a clear blue sky with some light clouds. The overall scene is a mix of dark, textured foreground and bright, open landscape beyond.

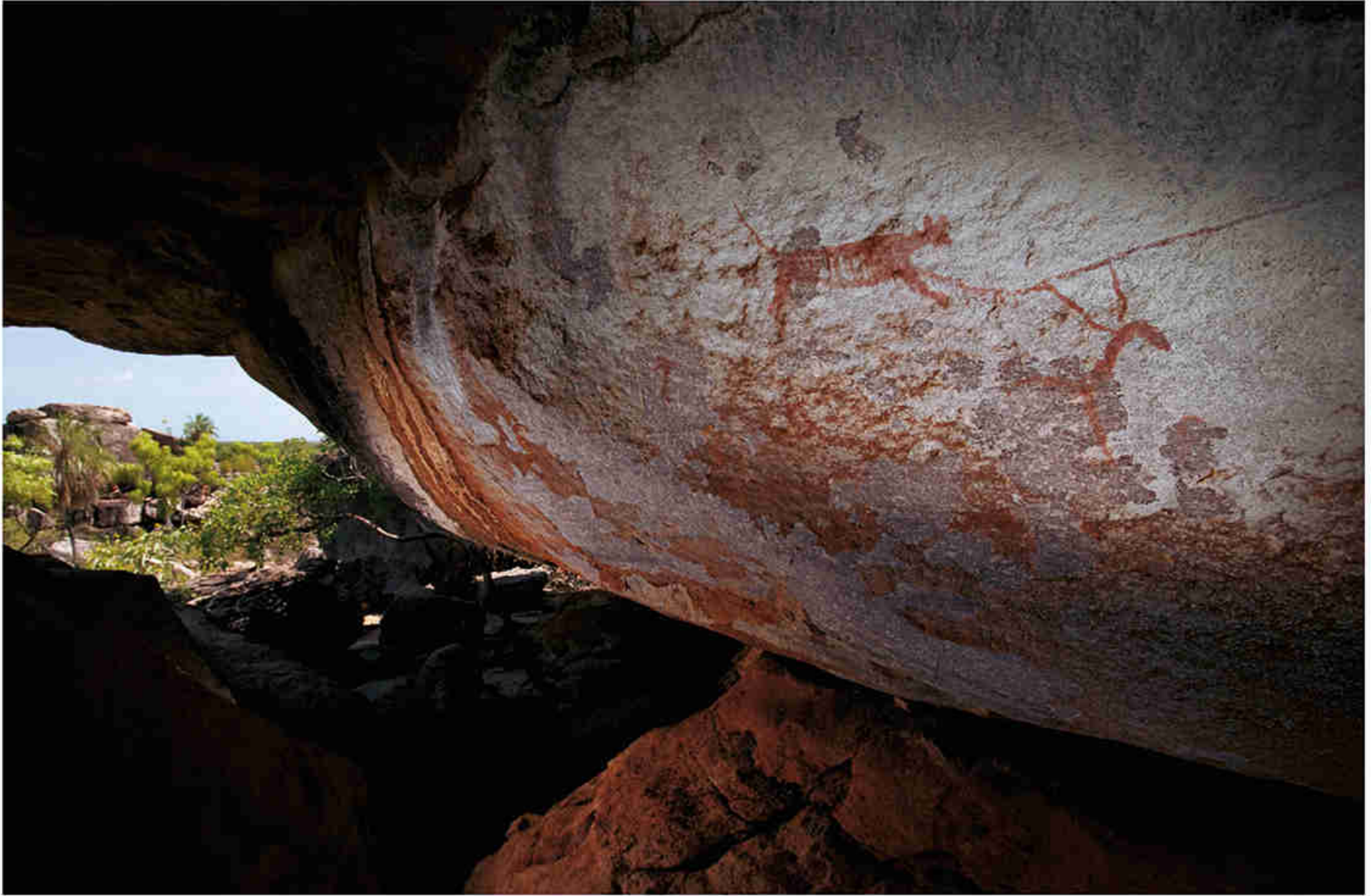
Imagine an Aboriginal hunting party 45,000 years ago crouched under an outcrop on the southern coast of Kangaroo Island. The semiarid scrubland they saw, similar to today's landscape, harbored megafauna the humans targeted for food.





Possibly the first direct evidence of human-megafauna interaction, rock art along the Drysdale River appears to show a hunter fending off a large

predator, likely *Thylacoleo carnifex*. Its massive jaws and teeth look lethal on a cast skeleton (bottom) at Adelaide's South Australian Museum.



(Continued from page 96) years ago, when falling sea levels allowed humans to finally reach the island, Flannery says. That parallels the situation of mammoths in Siberia and giant sloths in the Americas, which also found island refuges and survived for thousands of years after the broader extinction spasms on the mainland. This line of argument relies on the lack of fossil evidence for a prolonged human-megafauna overlap. If, however, we find evidence that human beings and megafauna lived side by side for many thousands or tens of thousands of years, then the role of humans in the extinctions would become blurry at best. Certainly it would disprove the notion of a rapid-fire, Martin-Flannery-style blitzkrieg.

As it happens, there is one place in the Australian outback where there may be such evidence. But which extinction hypothesis the evidence supports is still in question.

Cuddie Springs is an ephemeral lake in north-central New South Wales. Way back in 1878 a farmer sinking a well turned up megafauna bones at Cuddie. Today the person most vocal about the site, a woman who has spent her career excavating and interpreting its fossils, is Judith Field, an archaeologist at the University of Sydney.

In 1991, working as a graduate student at the site, Field discovered megafauna bones directly adjacent to stone tools—a headline-making find. She says there are two layers showing the association, one about 30,000 years old, the other 35,000 years old. If that dating is accurate, it would mean humans and megafauna coexisted in Australia for something like 20,000 years.

“What Cuddie Springs demonstrates is that you have an extended overlap of humans and megafauna,” Field says.

Nonsense, say her critics. They say the fossils have been moved from their original resting places and redeposited in younger sediments. Bert Roberts, a co-author with Flannery of a 2001 paper that argues for some kind of human

causation in megafauna extinctions, has examined grains of sand at Cuddie and says he has found very young grains mixed among the supposedly older fossils. That tells him that the stratigraphy is not clear-cut.

“If you don’t even know the order of events, it’s worthless, a waste of time,” Roberts says.

Rainer Grün, another Australian scientist who has dated fossils from the site, backs Roberts, saying Cuddie Springs is a bit disorderly: “This site shows clear signs of disturbance. And if it’s disturbed, anything is possible. It’s possible that the archaeological artifacts and the megafauna really do go together. I’m not denying that. You just can’t make the case for it.”

Field vigorously disputes that interpretation and argues that her critics are too wed

### THE EARTH PRESERVES ITS HISTORY HAPHAZARDLY. BONES DISINTEGRATE, LAND ERODES, ARTIFACTS CRUMBLE—THE PAST, IF NOT OBLITERATED, IS OBSCURED.

to a human impact hypothesis for the megafauna extinctions.

Unfortunately, Cuddie Springs was completely flooded and unreachable when I visited Australia to report this story (not that I could have, in any case, refereed the stratigraphic dispute). Field and I decided to drive instead to another famous boneyard in the same general region, a place called Wellington Caves. We drove for five hours from Sydney, across the Blue Mountains through a pastoral country that looks much like the rolling coastal lands of central California. When we pulled into the Wellington Caves parking lot, we found it guarded by a fiberglass *Diprotodon*.

*Diprotodon* was most mega of the megafauna, the largest known marsupial ever to tread the Earth. Bulky and stubby-legged, *Diprotodon* seems forever fated to be described in museums as “lumbering.”

We met Mike Augée, a scientist on-site who showed us the place where *Diprotodon* was first

discovered. It's a wide hole in the ground, a curving vertical shaft through a limestone hill, covered with a metal grate.

"This is a sacred site in Australian paleontology," Augee said.

Here's why: In 1830 a local official named George Rankin lowered himself into the cave on a rope tied to a protrusion in the cave wall. The protrusion turned out to be a bone.

A surveyor named Thomas Mitchell arrived later that year, explored the caves in the area, and shipped fossils off to Richard Owen, the British paleontologist who later gained fame for revealing the existence of dinosaurs. Owen recognized that the Wellington bones belonged to extinct marsupials. I asked Augee what he thinks happened to the megafauna.

## IF WE FIND EVIDENCE THAT HUMANS AND MEGAFUNA LIVED SIDE BY SIDE FOR MANY THOUSANDS OF YEARS, THE ROLE OF HUMANS IN THE EXTINCTIONS IS BLURRY AT BEST.

"I believe 100 percent in Tim Flannery's model," he said.

Field raised an eyebrow.

"But it's a cave," Augee added. "You can't trust charcoal to give you good dates in caves."

True. Things wash into caves. Water reworks sediments. Young, heavy things sink into the older layers. The earth is trickier than you think.

JUDITH FIELD MAKES a key point about her scientific data—there's not enough of it, not enough searching for the encoded narratives of the past.

"There are about 200 late Pleistocene sites in Australia," Field says. "Dates from fewer than 20 of these are accepted. What you're looking at is an incredibly thin data set from which these elaborate explanatory models are constructed."

Fortunately, there are bone hunters all over the continent. Amateur paleontologists play a crucial role in finding the megafauna bones. Lindsay Hatcher is one of them.

Hatcher is an easygoing fellow I met near the

town of Margaret River, about a four-hour drive south of Perth. Hatcher made one of the most significant fossil finds in recent years at Margaret River. In 1992 he decided to explore the aptly named Tight Entrance Cave. Hatcher took the path often used by spelunkers and found himself working his way right through a bunch of fossils. "This is an extinct kangaroo everyone is walking on," he told his friends. A hole in the floor of the cave turned out to be the eye socket of a huge kangaroo. More than 10,000 megafauna bones have since been hauled from Tight Entrance Cave.

Sometimes the bone hunters fly ultralights over the vast wasteland known as the Nullarbor Plain, the treeless underbelly of Australia along the Southern Ocean, and use GPS to

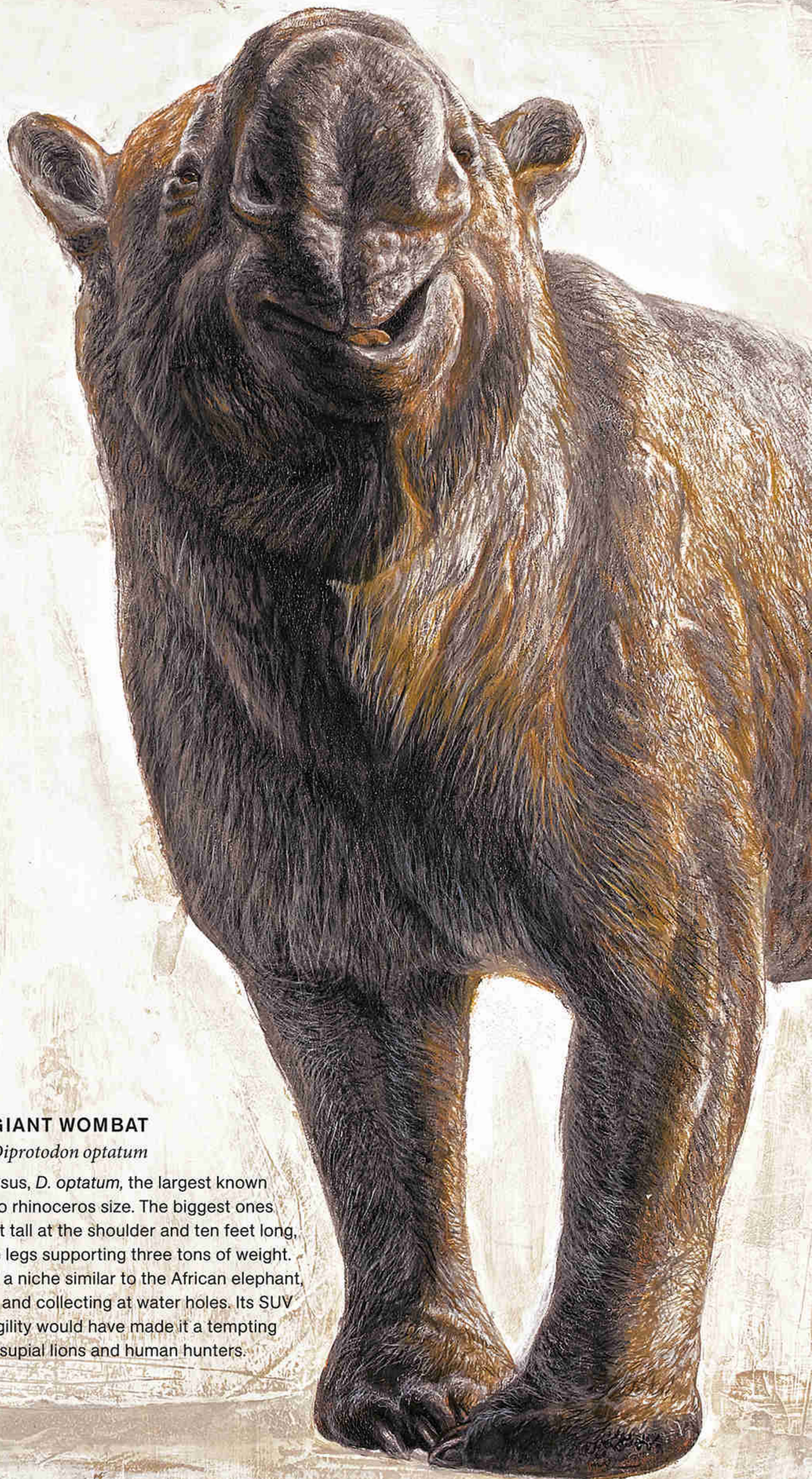
map the locations of cave entrances they see from the air. Hundreds of caves have been found recently in the Nullarbor, and four in particular have produced abundant

megafauna bones. Hatcher has also found caves with primitive boomerangs that he believes were used for hunting bats. But again, megafauna and humans aren't found in the same places—except in a tantalizing few.

Mammoth Cave has become a popular tourist destination near Margaret River. Between 1909 and 1915 the cave sediments that contained fossils were hauled out and examined in a haphazard manner that no scientist today would approve. ("They took the jewels, basically," Hatcher said.)

Still, one bone in particular has drawn extensive attention: a femur with a notch in it. There's a replica of the bone on display at Mammoth Cave. Hatcher thinks the bone was notched by a sharp tool. When he looks at Mammoth Cave, he sees an obvious human habitat, a great shelter during the Ice Age.

"Beautiful place for people to live. Sheltered. Permanent source of water in those days. There's plenty of bush tucker," Hatcher said as we



## **GIANT WOMBAT**

*Diprotodon optatum*

A plodding colossus, *D. optatum*, the largest known marsupial, grew to rhinoceros size. The biggest ones reached over six feet tall at the shoulder and ten feet long, their furry, pillar-like legs supporting three tons of weight. *Diprotodon* occupied a niche similar to the African elephant, browsing on shrubs and collecting at water holes. Its SUV size and lack of agility would have made it a tempting target for marsupial lions and human hunters.

wandered the illuminated chambers of the cavern.

Or was the femur notched by the razor-sharp tooth of a marsupial lion? Everything's interpretation. What's certain is that Hatcher will keep searching, doing his part to solve the continent's greatest mystery.

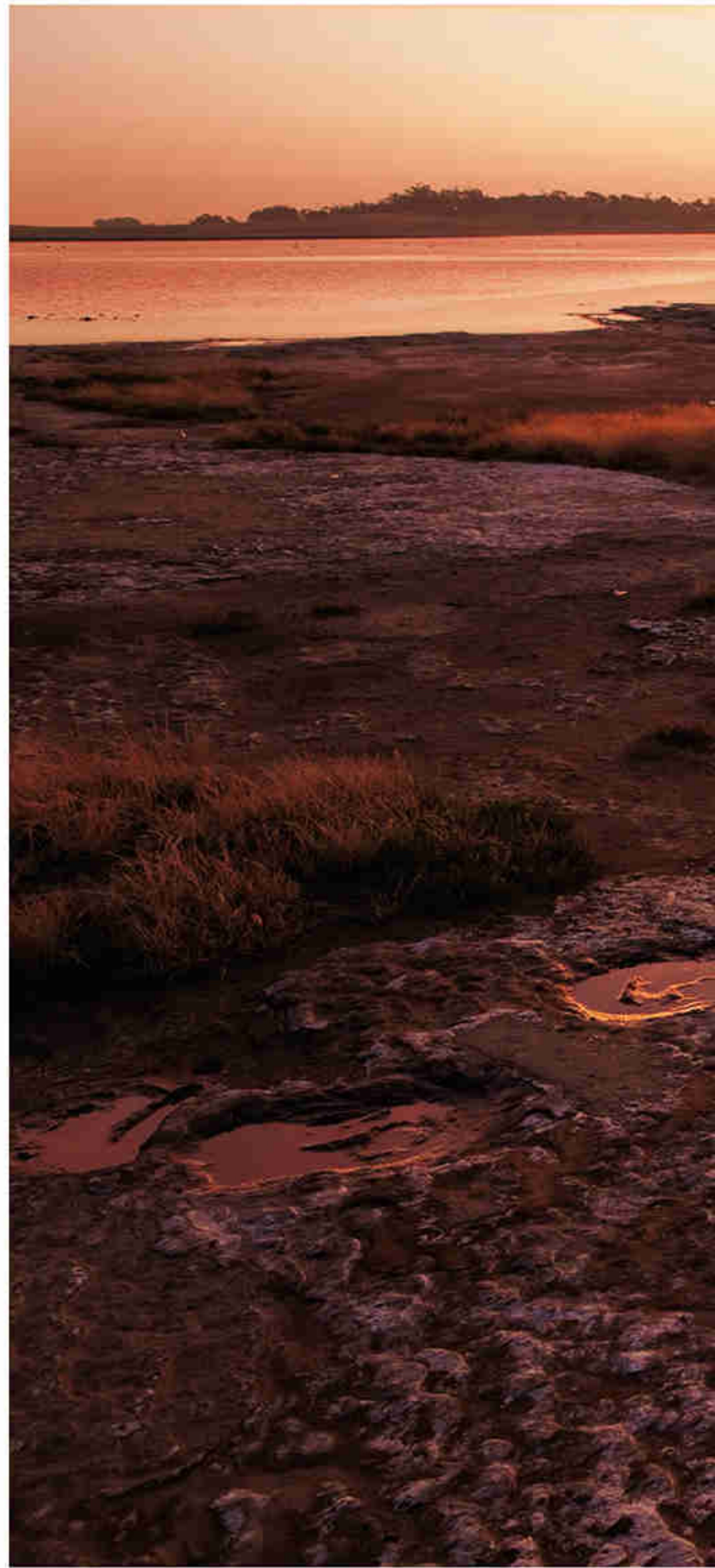
THE EARTH PRESERVES its history haphazardly. Bones disintegrate, artifacts crumble, the land erodes, the climate changes, forests come and go, rivers change their course—and the past, if not obliterated, is steadily obscured. By necessity, narratives are constructed from limited data.

Australia's first people expressed themselves in rock art found on outcrops across the continent. I caught up with Peter Murray, a paleontologist based in Alice Springs. We drove to a site south of town where the red sandstone is adorned with circular and serpentine symbols. "Quite attractive. And enigmatic," Murray said. "But no megafauna."

Murray has, however, studied a rock painting in Arnhem Land, in far northern Australia, that shows what looks very much like a megafauna marsupial known as *Palorchestes*. Often compared to a tapir, *Palorchestes* had a small, mobile trunk and a long tongue like that of a giraffe. In Western Australia another ambiguous rock-art site shows what appears to be a human hunter with either a marsupial lion or a Tasmanian tiger—a major distinction, since the marsupial lion went extinct and the much smaller Tasmanian tiger survived into the historical era.

Murray, over an Alice Springs dinner of camel with beet sauce and some smoked emu, said of his profession, "Every step of the way involves interpretation. The data doesn't just speak for itself."

THE BLITZKRIEG HYPOTHESIS paints the alarming picture of human beings rapidly wiping out a great number of animals. But there's an even more ominous scenario: The extinctions don't happen quickly because of anything that resembles overkill but rather through a very incremental sequence of events, including



climate change, during which the people involved could not fully discern what was happening to their environment.

Which takes us to today.

"The way we have lived and are living is destroying our future," Flannery says. Yet we are only gradually figuring out how we're changing our world and the extent to which our efflorescence is harming or even driving to extinction countless species.

After tramping around Australia for a couple of weeks, poking into caves in three different states and hiking the outback, I returned to Sydney for a review session with Judith Field. She spoke



On a drying lake bed in Victoria, a farmer in 2007 alerted scientists to a major find: well-preserved tracks of a *Diprotodon*. The slow-moving behemoth had been crossing a volcanic plain 100,000 years ago, when megafauna still walked tall.

again of the controversial stratigraphy of Cuddie Springs, of the layers where megafauna and human tools may be associated, of the history of the enmity among the scientists. As I listened, she suddenly said, “Are you very tired?” My chin was cradled in my hand—I guess I looked as though

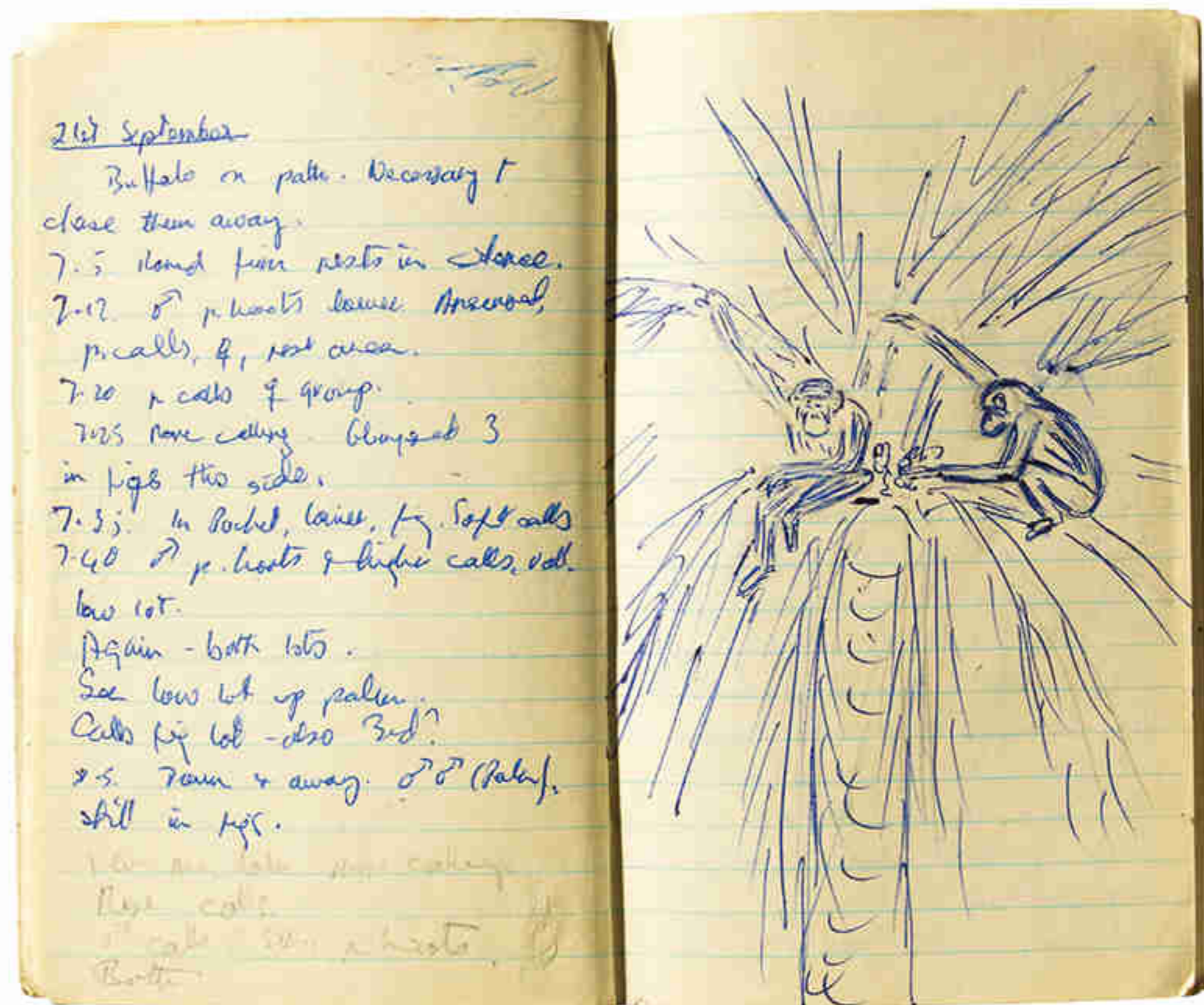
I was about to put my head down on the table.

“I’m sorry I wasn’t able to crystallize the story for you,” she said weeks later on the phone.

“Oh, it’s crystal clear,” I said. “It’s a perfect muddle.”

But we’ll muddle on. Science is a laborious process, and sometimes progress comes only with many stumbles and blind alleys. Think of Rod Wells in Victoria Fossil Cave, slithering on his belly through passages so narrow that he had to turn his head sideways to squeeze forward. Scrambling. Digging.

Sometimes we will strike an impassable obstacle and have to back up the way we came. □



Jane's entry in a 1961 field notebook

# Jane

## Fifty Years at Gombe

In 1960 a spirited animal lover with no scientific training set up camp in Tanganyika's Gombe Stream Game Reserve to observe chimpanzees. Today Jane Goodall's name is synonymous with the protection of a beloved species. At Gombe—one of the longest, most detailed studies of any wild animal—revelations about chimps keep coming.







By David Quammen

**M**OST OF US DON'T ENTER UPON OUR life's destiny at any neatly discernible time. Jane Goodall did. On the morning of July 14, 1960, she stepped onto a pebble beach along a remote stretch of the east shore of Lake Tanganyika. It was her first arrival at what was then called the Gombe Stream Game Reserve, a small protected area that had been established by the British colonial government back in 1943. She had brought a tent, a few tin plates, a cup without a handle, a shoddy pair of binoculars, an African cook named Dominic, and—as a companion, at the insistence of people who feared for her safety in the wilds of pre-independence Tanganyika—her mother. She had come to study chimpanzees. Or anyway, to try. Casual observers expected her to fail. One person, the paleontologist Louis Leakey, who had recruited her to the task up in Nairobi, believed she might succeed.

A group of local men, camped near their fishing nets along the beach, greeted the Goodall party and helped bring up the gear. Jane and her mother spent the afternoon putting their camp in order. Then, around 5 p.m., somebody reported having seen a chimpanzee. “So off we went,” Jane wrote later that night in her journal, “and there was the chimp.” She had gotten only a distant, indistinct glimpse. “It moved away as we drew level with the crowd of fishermen gazing at it, and, though we climbed the neighbouring slope, we didn't see it again.” But she had noticed, and recorded, some bent branches flattened together in a nearby tree: a chimp nest. That datum, that first nest, was the starting point of what has become one of the most significant ongoing sagas in modern field biology: the continuous, minutely detailed, 50-year study, by Jane Goodall and others, of the behavior of the chimps of Gombe.

Science history, with the charm of a fairy-tale legend, records some of the high points and iconic details of that saga. Young Miss Goodall had no scientific credentials when she began, not even an undergraduate degree. She was a bright, motivated secretarial school graduate from England who had always loved animals and dreamed of studying them in Africa. She came from a family of strong women, little money, and absent men. During the early weeks at Gombe she struggled, groping for a methodology, losing time to a fever that was probably malaria, hiking many miles in the forested mountains, and glimpsing few chimpanzees, until an elderly male with grizzled chin whiskers extended to her a tentative, startling gesture of trust. She named the old chimp David Greybeard. Thanks partly to him, she made three observations that rattled the comfortable wisdoms of physical anthropology:

Who's watching whom? Jane trades gazes with Fifi, one of her original study subjects. The wooden fence kept chimps from charging into camp and scattering provisions. Years later Fifi climbed to top matriarch, with seven of nine offspring surviving—the most of any female. She and her youngest disappeared in 2004, “a really sad time,” Jane says.

stood nearly eight years, was that "man" evolution when the creature begins to m

Since the chimpanzees are making t even though these tools are primitive, natives, either they accept chimpanzees must redefine "man".

March 21, 1963

**From: LOUIS LEAKEY**

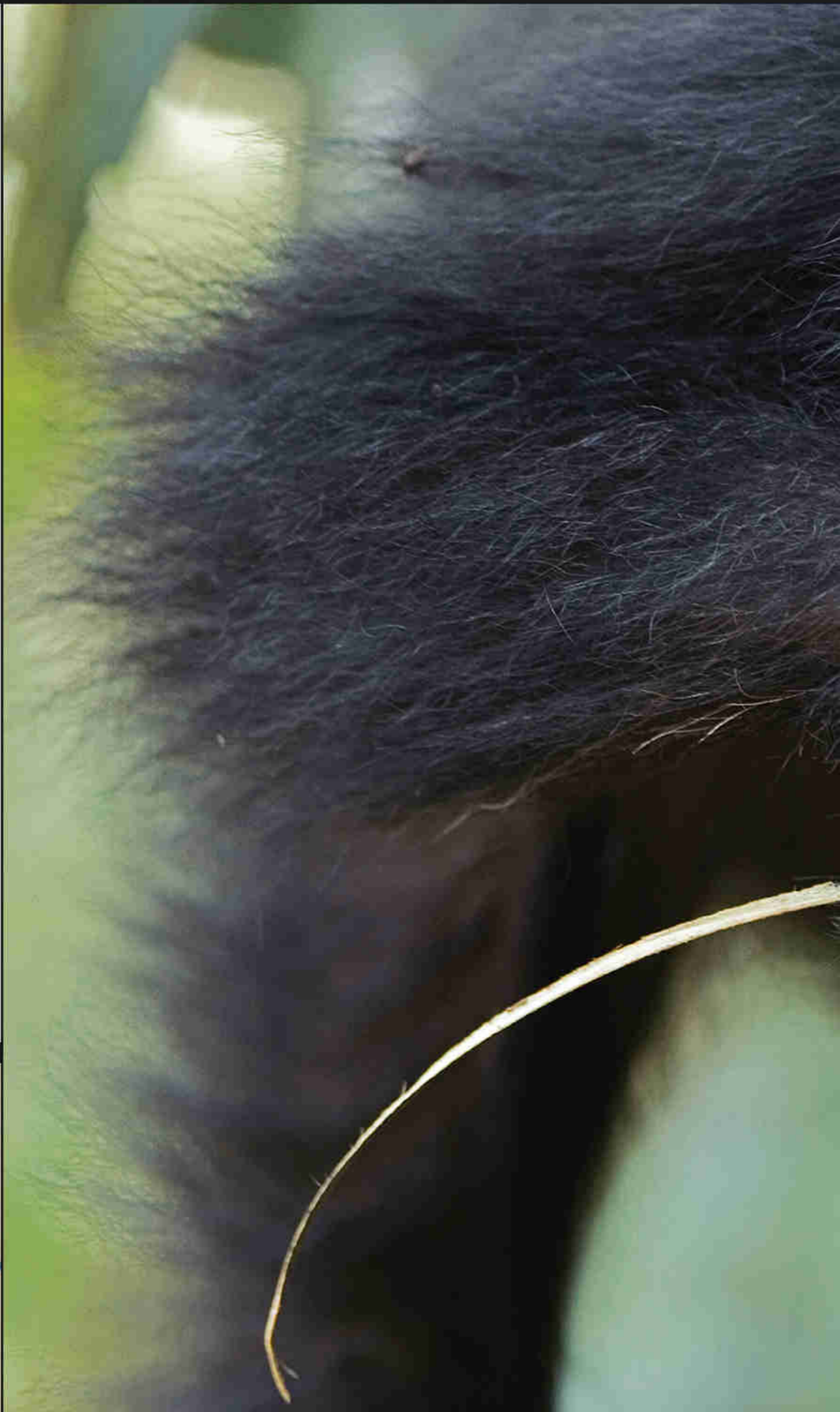
*Correspondence to  
National Geographic  
executive Melvin Payne*

In a memo, Leakey—Jane's mentor—credited her with a discovery that helped redefine what it means to be human: Chimps make tools. Three years earlier Jane had observed chimps fishing for termites with plant stems. This chimp, photographed in 2005, displays humanlike concentration as he snags a termite snack.

INGO ARNDT, MINDEN PICTURES (RIGHT);  
NATIONAL GEOGRAPHIC ARCHIVES &  
SPECIAL COLLECTIONS

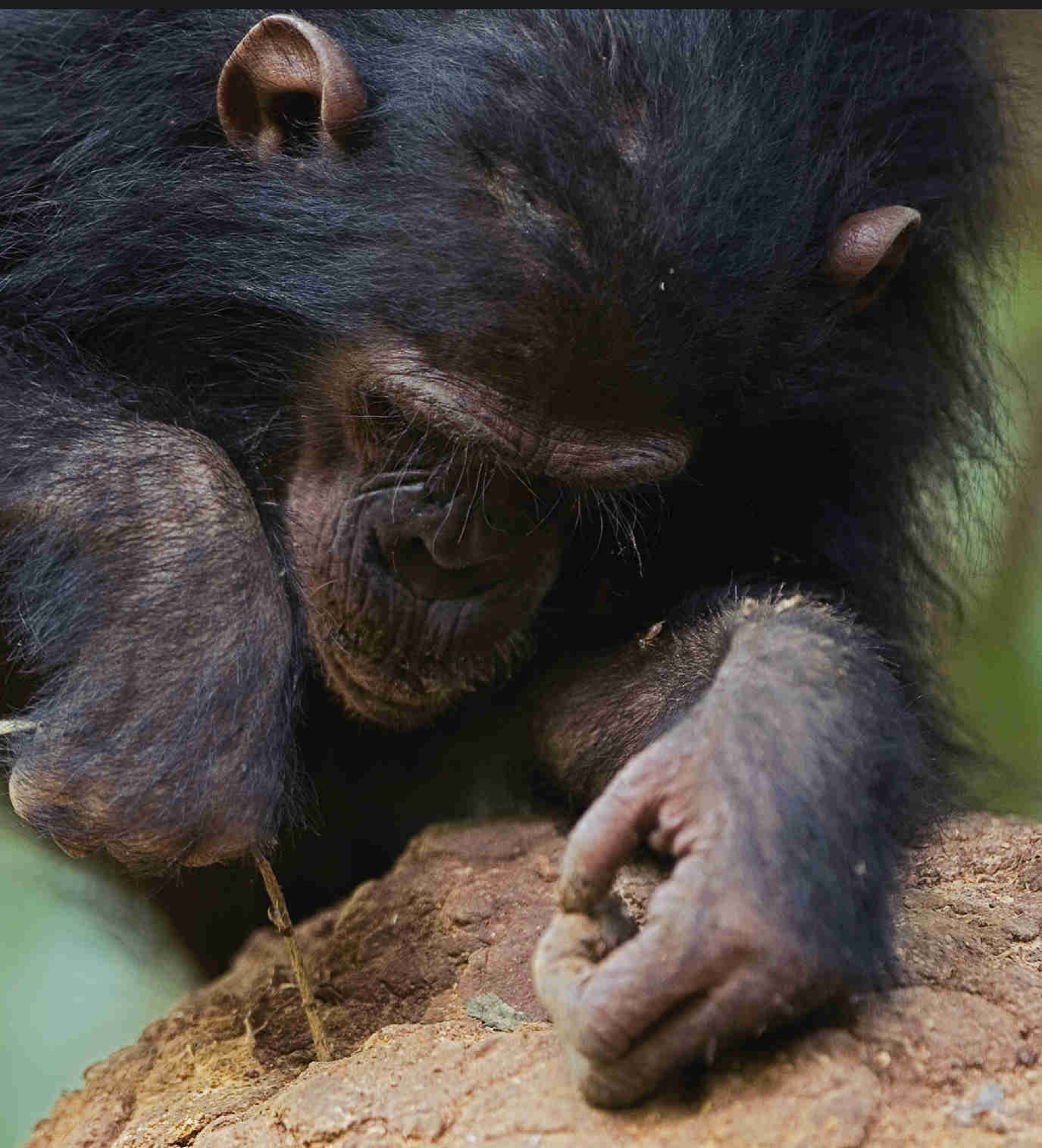
L.S.B. Leakey

*L.S.B. Leakey*



starts at the stage of primate  
make tools to a set and regular pattern"

ools to a "set and regular pattern,"  
scientists are faced with two alter-  
as man, by definition, or else they





#### HIGHLIGHTS OF 50 YEARS OF GOMBE RESEARCH

### CHIMPANZEES HUNT MAMMALS AS FOOD

Published in 1963

Jane's first key finding ended the long-held assumption that chimps were vegetarians. Meat is relished and shared.

### CHIMPANZEES MAKE AND USE TOOLS

Published in 1963

Examples include probing termite mounds with plant stems and using leaves as sponges. Young chimps learn by watching others. Cultural traditions differ among chimp populations and are more extensive and varied than those of any other nonhuman animal.

### CHIMPANZEES HAVE RICH SOCIAL LIVES AND FAMILY TIES

Published in 1965

Complex social interactions among chimps include robust maternal bonds that last into adulthood.

### FEMALE CHIMPANZEES SEEK MULTIPLE MATES

Published in 1971

Females in estrus often mate with all males in a community. Some males try to monopolize a female or take her away on a consortship.

### FEMALE CHIMPANZEES COMMIT INFANTICIDE

Published in 1977

Competition among females for good feeding areas may include the killing of other females' infants.

meat eating by chimps (who had been presumed vegetarian), tool use by chimps (in the form of plant stems probed into termite mounds), and toolmaking (stripping leaves from stems), supposedly a unique trait of human premeditation. Each of those discoveries further narrowed the perceived gap of intelligence and culture between *Homo sapiens* and *Pan troglodytes*.

The toolmaking observation was the most epochal of the three, causing a furor within anthropological circles because “man the toolmaker” held sway as an almost canonical definition of our species. Louis Leakey, thrilled by Jane's news, wrote to her: “Now we must redefine ‘tool,’ redefine ‘man,’ or accept chimpanzees as humans.” It was a memorable line, marking a very important new stage in thinking about human essence. Another interesting point to remember is that, paradigm shifting or not, all three of those most celebrated discoveries were made by Jane (everyone calls her Jane; there is no sensible way not to call her Jane) within her first four months in the field. She got off to a fast start. But the real measure of her work at Gombe can't be taken with such a short ruler.

The great thing about Gombe is not that Jane Goodall “redefined” humankind but that she set a new standard, a very high standard, for behavioral study of apes in the wild, focusing on individual characteristics as well as collective patterns. She created a research program, a set of protocols and ethics, an intellectual momentum—she created, in fact, a relationship between the scientific world and one community of chimpanzees—that has grown far beyond what one woman could do. The Gombe project has enlarged in many dimensions, has endured crises, has evolved to serve purposes that neither she nor Louis Leakey foresaw, and has come to embrace methods (satellite mapping, endocrinology, molecular genetics) and address questions that carry far beyond the field of animal behavior. For instance, techniques of molecular analysis, applied to fecal and urine samples that can be gathered without need for capture and handling, reveal new insights about genetic relationships among the chimps and the presence of disease microbes in some of them. Still, a poignant irony that lies near the heart of this scientific triumph, on its golden anniversary, is that the more we learn about the chimps of Gombe, the more we have cause to worry for their continued survival.

Two revelations in particular have raised concern. One involves geography, the other involves disease. The world's most beloved and well-studied population of chimpanzees is isolated on an island of habitat that's too small for long-term viability. And now some of them seem to be dying from their version of AIDS.

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Contributing writer David Quammen's book on zoonotic diseases will be published next year by W. W. Norton.



**T**HE ISSUE OF HOW TO STUDY CHIMPANZEES, and of what can be inferred from behavioral observations, has faced Jane Goodall since early in her career. It began coming into focus after her first field season, when Louis Leakey informed Jane of his next bright idea for shaping her life: He would get her into a Ph.D. program in ethology at Cambridge University.

This doctorate seemed a stretch on two counts. First, her lack of any undergraduate degree whatsoever. Second, she had always aspired to be a naturalist, or maybe a journalist, but the word “scientist” hadn’t figured in her dreaming. “I didn’t even know what ethology was,” she told me recently. “I had to wait quite a while before I realized it simply meant studying behavior.” Once enrolled at Cambridge, she found herself crosswise with departmental elders and the prevailing certitudes of the field. “It was a bit shocking to be told I’d done everything wrong. Everything.” By then she had 15 months of field data from Gombe, most of it gathered through patient observation of individuals she knew by monikers such as David Greybeard, Mike, Olly, and Fifi. Such personification didn’t play well at Cambridge; to impute individuality and emotion to nonhuman animals was anthropomorphism, not ethology. “Fortunately, I thought back to my first teacher, when I was a child, who taught me that that wasn’t true.” Her first teacher had been her dog, Rusty. “You cannot share your life in a meaningful way with any kind of animal with a reasonably well-developed brain and not realize that animals have personalities.” She pushed back against the prevailing view—one thing about gentle Jane, she always pushes back—and on February 9, 1966, she became Dr. Jane Goodall.

In 1968 the little game reserve underwent its own graduation, becoming Tanzania’s Gombe National Park. By then Jane was receiving research funding from the National Geographic Society. She was married and a mother and famous worldwide, owing in part to her articles for this magazine and her comely, forceful presence in a televised film, *Miss Goodall and the Wild Chimpanzees*. She had institutionalized her field camp, in order to fund and perpetuate it, as the Gombe Stream Research Center (GSRC). In 1971 she published *In the Shadow of Man*, her account of the early Gombe studies and adventures, which became a best seller. Around the same time, she began hosting students and graduate researchers to help with chimp-data collection and other research at Gombe. Her influence on modern primatology, noisily bruited about by Leakey, is more quietly suggested by the long list of Gombe alums who have gone on to do important scientific work, including Richard Wrangham, Caroline Tutin, Craig Packer, Tim Clutton-Brock, Geza Teleki, William McGrew, Anthony Collins,

Twigs used by Gombe chimps for termite fishing (above, actual size); some probes are much longer.

**“It was a bit shocking to be told I’d done everything wrong. Everything.”**

—Jane Goodall

Four-year-old twins Golden and Glitter ride on mom, Gremlin, in 2002. The twins are now of breeding age.



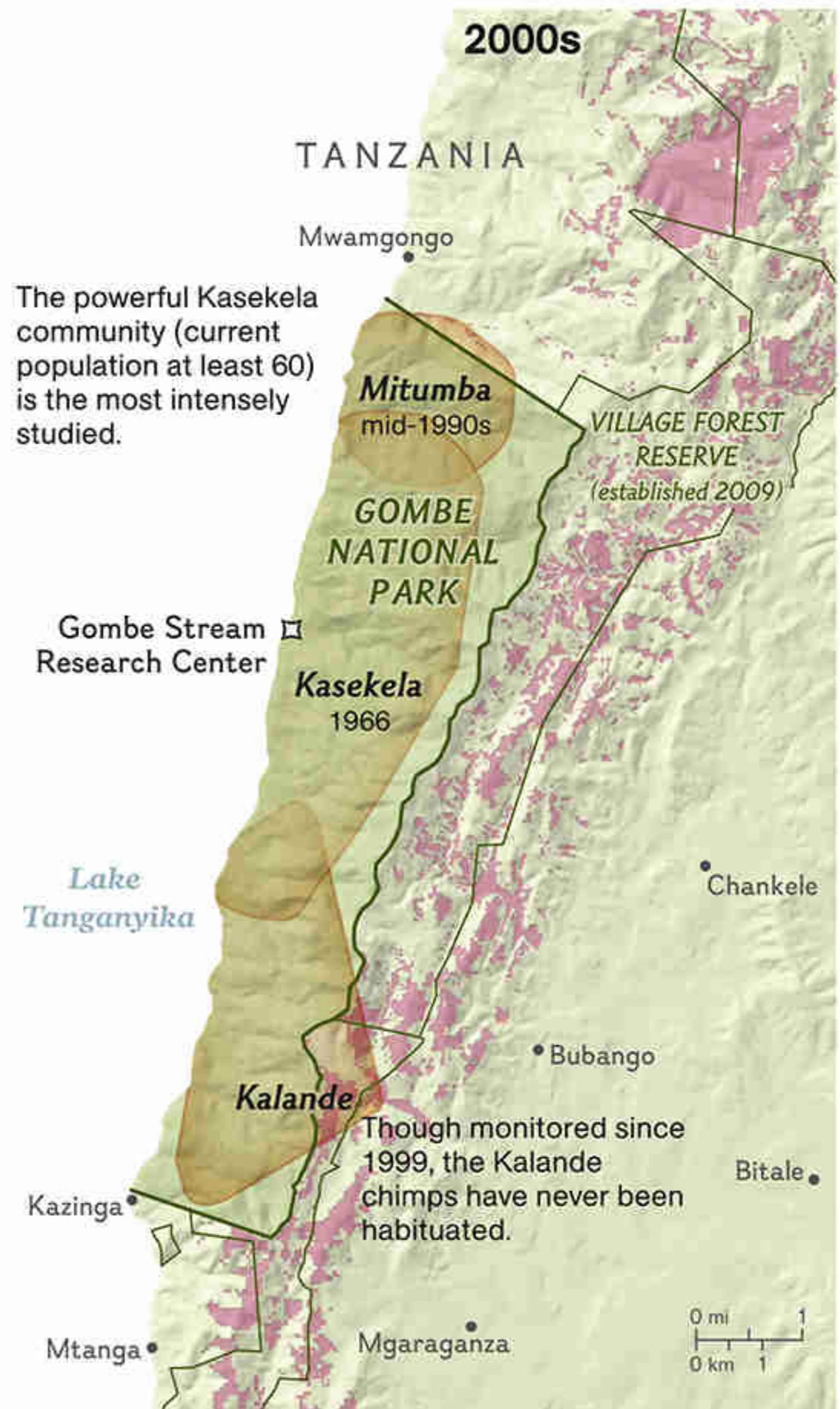
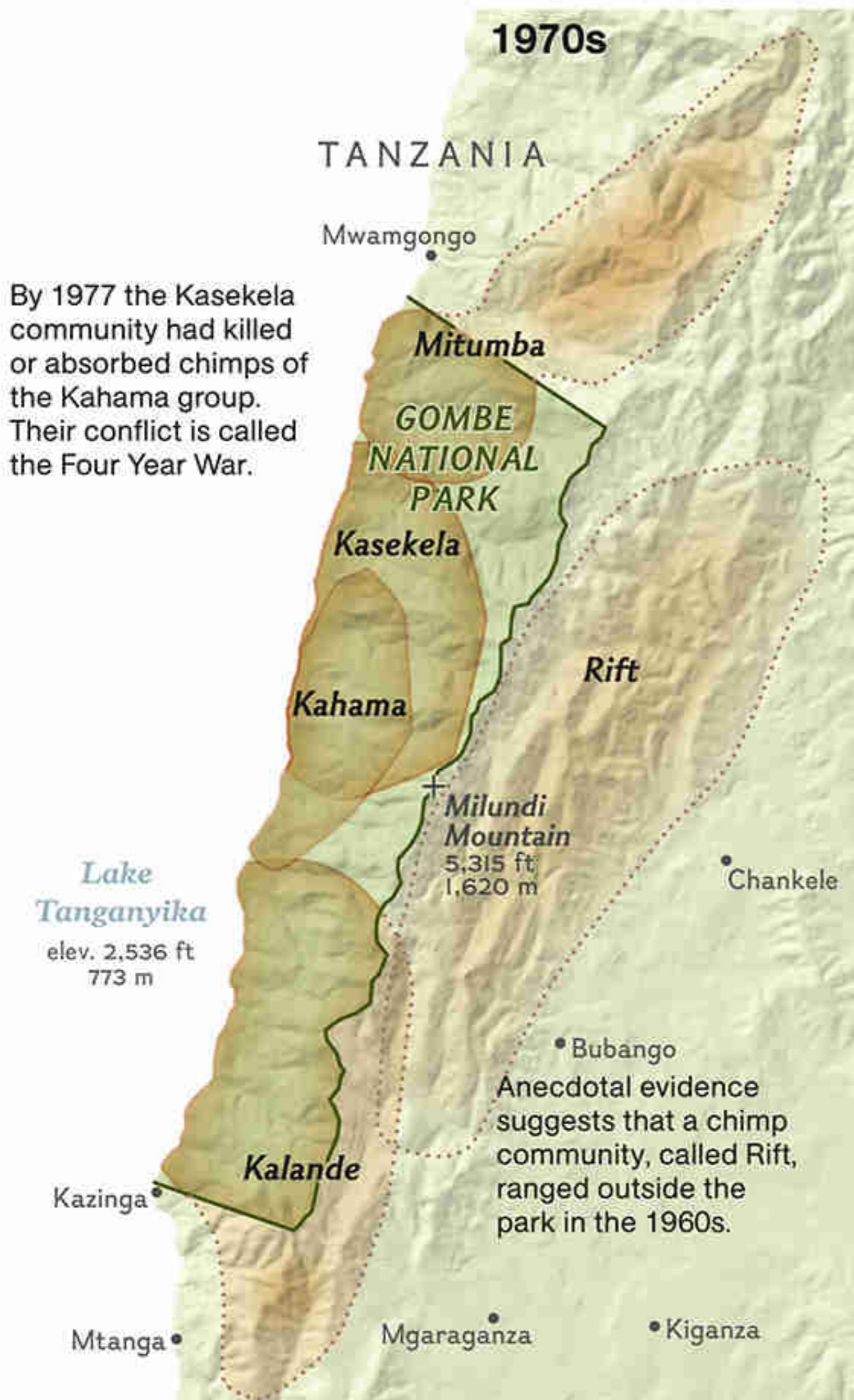
# A Haven for Chimps

An area of 13.5 square miles seemed enough in 1968, when Gombe was named a national park. But studies have since shown that this primate population—about a hundred chimps—will need a larger foraging area to thrive in the long term. As farms and oil palm plantations have closed in on the park, chimp home ranges outside have shrunk, likely intensifying territorial conflicts. Disease has added to the toll. The Jane Goodall Institute is now promoting livelihoods that both benefit villagers and restore chimp habitat.



## GOMBE'S CHIMPANZEE COMMUNITIES

1966 Community range\*; year habituated Deforestation since 1972  
 Mitumba and Kalande ranges in the 1970s are estimates; ranges outside the park are speculative.



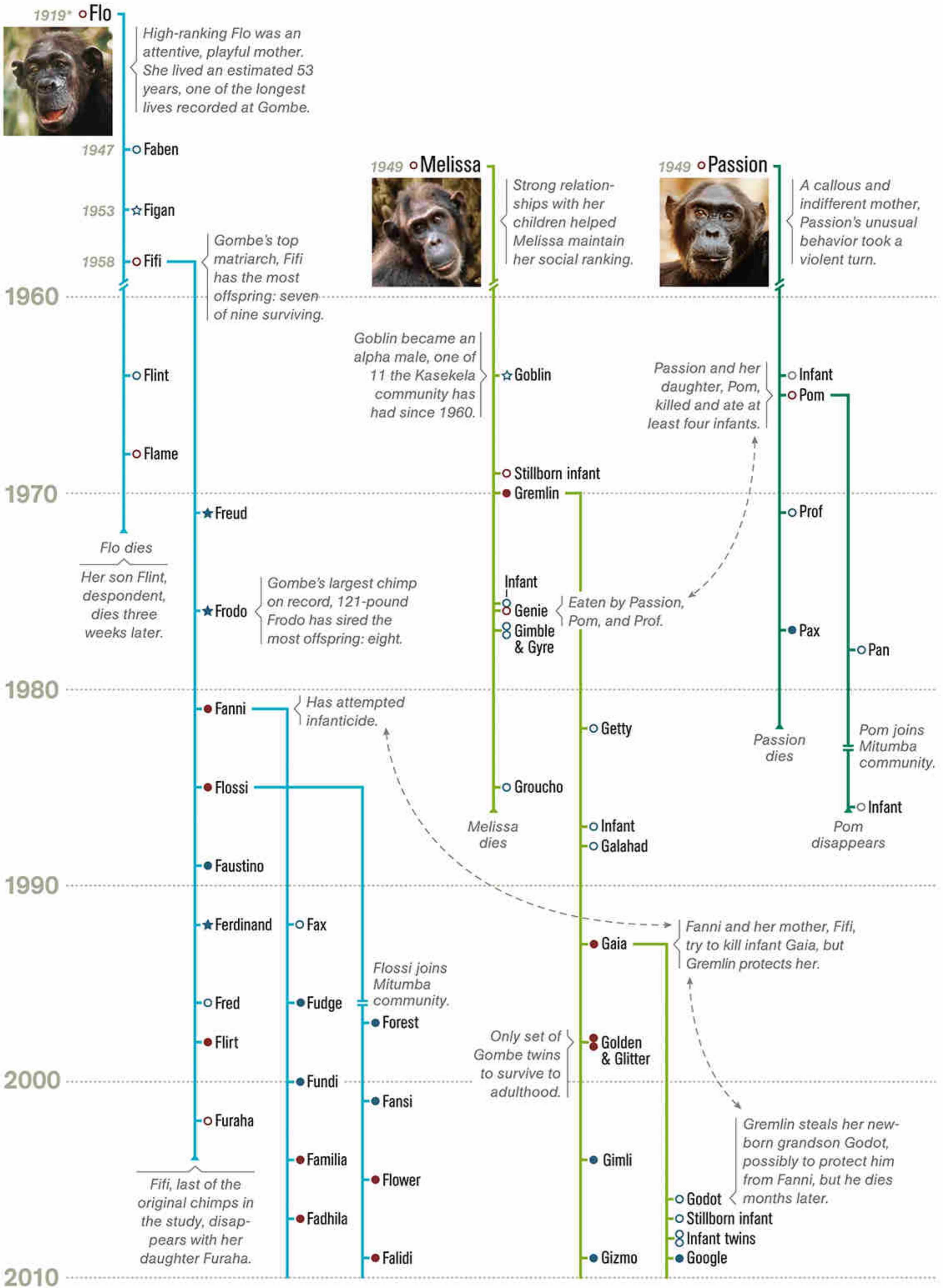
MAPS: MARTIN GAMACHE, NGM STAFF; INTERNATIONAL MAPPING ASSOCIATES. GRAPHIC: LAWSON PARKER, NGM STAFF  
 MAP SOURCES: LILIAN PINTEA, JANE GOODALL INSTITUTE; ANNE PUSEY, DUKE UNIVERSITY; MIKE WILSON AND DEUS CYPRIAN, UNIVERSITY OF MINNESOTA  
 GRAPHIC SOURCE: JOANN C. SCHUMACHER-STANKEY. PHOTOS: ANUP SHAH, NATURE PICTURE LIBRARY (TOP); COURTESY JANE GOODALL INSTITUTE (OPPOSITE, ALL)



## FAMILY TIES

Three matriarchs in the Kasekela community became key personalities in the study of chimp reproduction, nurturing, and social behavior. Family lines are traced through the mothers, since paternity was uncertain before DNA testing.

	Dead	Alive
Male	○	●
Alpha male	☆	★
Female	○	●
Unknown	○	



\*Birth dates before 1960 are estimates.

**“You cannot share your life with any animal with a well-developed brain and not realize that animals have personalities.”**

—Jane Goodall

Shadrack Kamenya, Jim Moore, and Anne Pusey. The last of those, Pusey, now professor and chair of evolutionary anthropology at Duke University, also serves the Jane Goodall Institute (established in 1977) as director of its Center for Primate Studies. Among other duties, she curates the 22 file cabinets full of field data—the notebooks and journal pages and check sheets, some in English, some in Swahili—from 50 years of chimp study at Gombe.

That 50-year run suffered one traumatic interruption. On the night of May 19, 1975, three young Americans and a Dutch woman were kidnapped by rebel soldiers who had come across Lake Tanganyika from Zaire. The four hostages were eventually released, but it no longer seemed prudent for the Gombe Stream Research Center to welcome expatriate researchers and helpers—as Anthony Collins explained to me.

Collins was then a young British biologist with muttonchop sideburns and a strong interest in baboons, the other most conspicuous primate at Gombe. In addition to his baboon research, he has continued to play important administrative roles in the Jane Goodall Institute and at GSRC itself, off and on, for almost 40 years. He recalls May 19, 1975, as “the day the world changed, as far as Gombe was concerned.” Collins was absent that night but returned promptly to help cope with the aftermath. “It was not entirely bad,” he told me. The bad part was that foreign researchers could no longer work at Gombe; Jane herself couldn’t work there, not without a military escort, for some years. “The good thing about it was that the responsibility for data collection went straightaway, the following day, to the Tanzanian field staff.” Those Tanzanians had each received at least a year’s training in data collection but still functioned partly as trackers, helping locate the chimps, identifying plants, and making sure the *mzungu* (white) researchers got back to camp safely each night before dark. Then came the kidnapping, whereupon the Tanzanians stepped up, and “on that day the baton was passed to them,” Collins said. Only one day’s worth of data was missed. Today the chief of chimpanzee researchers at Gombe is Gabo Paulo, supervising the field observations and data gathering of Methodi Vyampi, Magombe Yahaya, Amri Yahaya, and 20 other Tanzanians.

**H**UMAN CONFLICTS OVERFLOWING FROM neighboring countries weren’t the only sort of tribulation that affected Gombe. Chimpanzee politics could also be violent. Beginning in 1974, the Kasekela community (the main focus of Gombe research) conducted a series of bloody raids against a smaller subgroup called Kahama. That period of aggression, known in Gombe



annals as the Four Year War, led to the death of some individuals, the annihilation of the Kahama subgroup, and the annexation of its territory by Kasekela. Even within the Kasekela community, struggles among males for the alpha position are highly political and physical, while among females there have been cases of one mother killing a rival mother's infant. "When I first started at Gombe," Jane has written, "I thought the chimps were nicer than we are. But time has revealed that they are not. They can be just as awful."

Gombe was never Eden. Disease intruded too. In 1966 came an outbreak of something virulent (probably polio, contracted from humans nearby), and six chimps died or disappeared. Six others were partially paralyzed. Two years later, David Greybeard and four others vanished while a respiratory bug (influenza? bacterial pneumonia?) swept through. Nine more chimps died in early 1987 from pneumonia. These episodes, reflecting the susceptibility of chimps to human-carried pathogens, help explain why scientists at Gombe are acutely concerned with the subject of infectious disease.

That concern has been heightened by landscape changes outside the park boundaries. Over the decades people in the surrounding villages have struggled to live ordinary lives—cutting firewood from the steep hillsides, planting crops on those slopes, burning the grassy and scrubby areas each dry season for fertilizing ash, having babies, and trying to feed them. By the early 1990s deforestation and erosion had made Gombe National Park an ecological island, surrounded by human impact on three sides and Lake Tanganyika on the fourth. Within that island lived no

Bananas gave Jane an edge. A steady supply lured chimps and enabled her to gain their trust. David Greybeard (above), who once ate about 50 bananas in a sitting, was the first Gombe chimp to lose his fear of human contact. When he let Jane groom him, it was, she wrote, "a proud moment." It is now known that chimps lack immunity to some human diseases, so Gombe researchers must keep at least 25 feet away.

## GOMBE SCRAPBOOK

For the past 50 years, Gombe has had two families—the chimps who live in the park and the scores of researchers who've watched them. Led by Jane, they've camped out for months, crouched in the woods, and spent countless hours observing our closest kin. Tanzanian helpers became trackers and data collectors in the 1970s; now they are largely in charge. "It's a really vibrant place for research," Jane says. With today's mapping and DNA technologies, "the capabilities are vaster than anything I could have imagined as I sat with my notebook and slide rule."

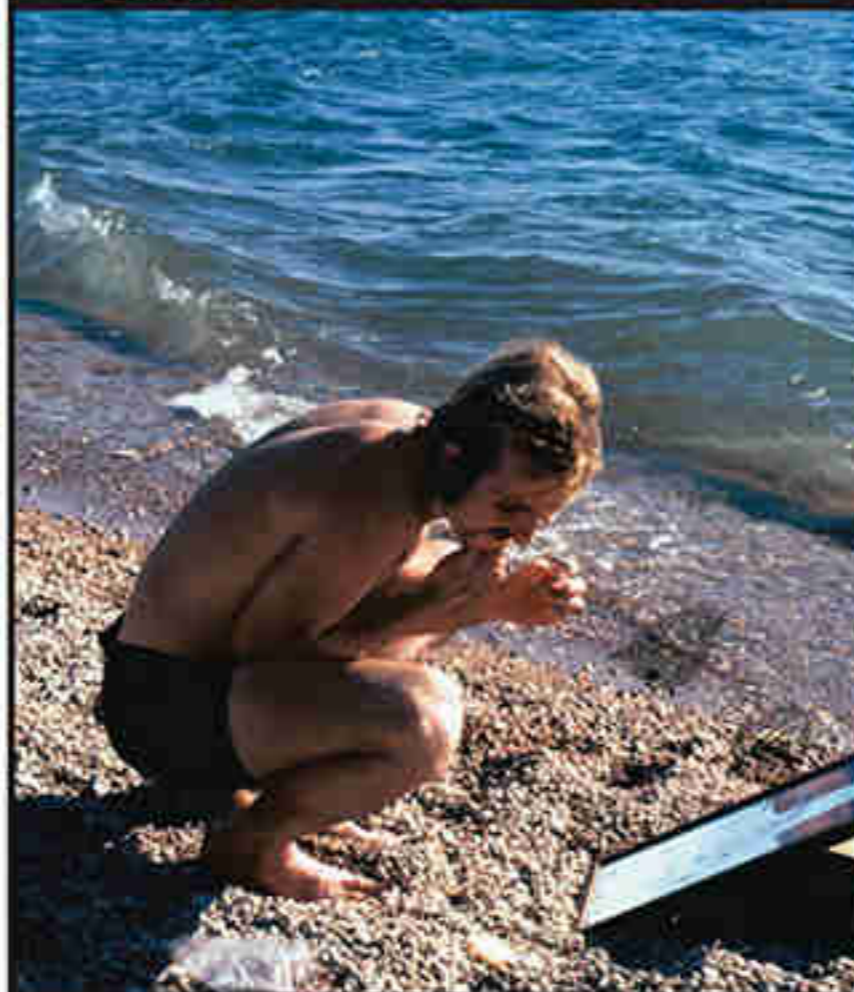
- A:** News of a grant moves Jane and colleagues to dance
- B:** Chimps peer in a mirror
- C:** Juma Mkukwe (left) and Yassini Selemani with Figan
- D:** Methodi Vyampi observes Zeus
- E:** Jim Moore shaves off his beard
- F:** Staff document chimps with prey
- G:** Jane with Gombe staff
- H:** Lori Baldwin retrieves a pen from Atlas
- I:** Collecting chimp food: ants
- J:** Watching Gremlin and family
- K:** Selemani Yahaya jots down notes
- L:** Scanning habitat edge
- M:** David Bygott at Gombe's fringe
- N:** Jane and partner show the flag
- O:** Anne Shouldice ducks Mustard
- P:** Chimp health monitoring team
- Q:** Jane with researcher Hilali Matama
- R:** Flo
- S:** David Greybeard earns a banana
- T:** Mike Wilson, then director of field research
- U:** Tanganyika (today Tanzania) stamp

PHOTOS: CAROLINE VAN ZINNICO BERGMANN (C); EMILIE VAN ZINNICO BERGMANN-RISS (A); COURTESY DAVID BYGOTT (B, F, H, M, O, R); ELIZABETH LONSDORF, LINCOLN PARK ZOO (L, P); NATIONAL GEOGRAPHIC ARCHIVES & SPECIAL COLLECTIONS (U); MICHAEL NICHOLS, NGM STAFF (Q); LISA H. NOWELL (E); ROBERT O'MALLEY (G, I); HUGO VAN LAWICK (N, S); COURTESY MICHAEL L. WILSON (D, J, K, T)



A. 1973

B. 1970



E. 1974



F. 1971



I. 2010



O. 1971



L. 2006

M. 1971

N. 1962





C. 1974



D. 2008



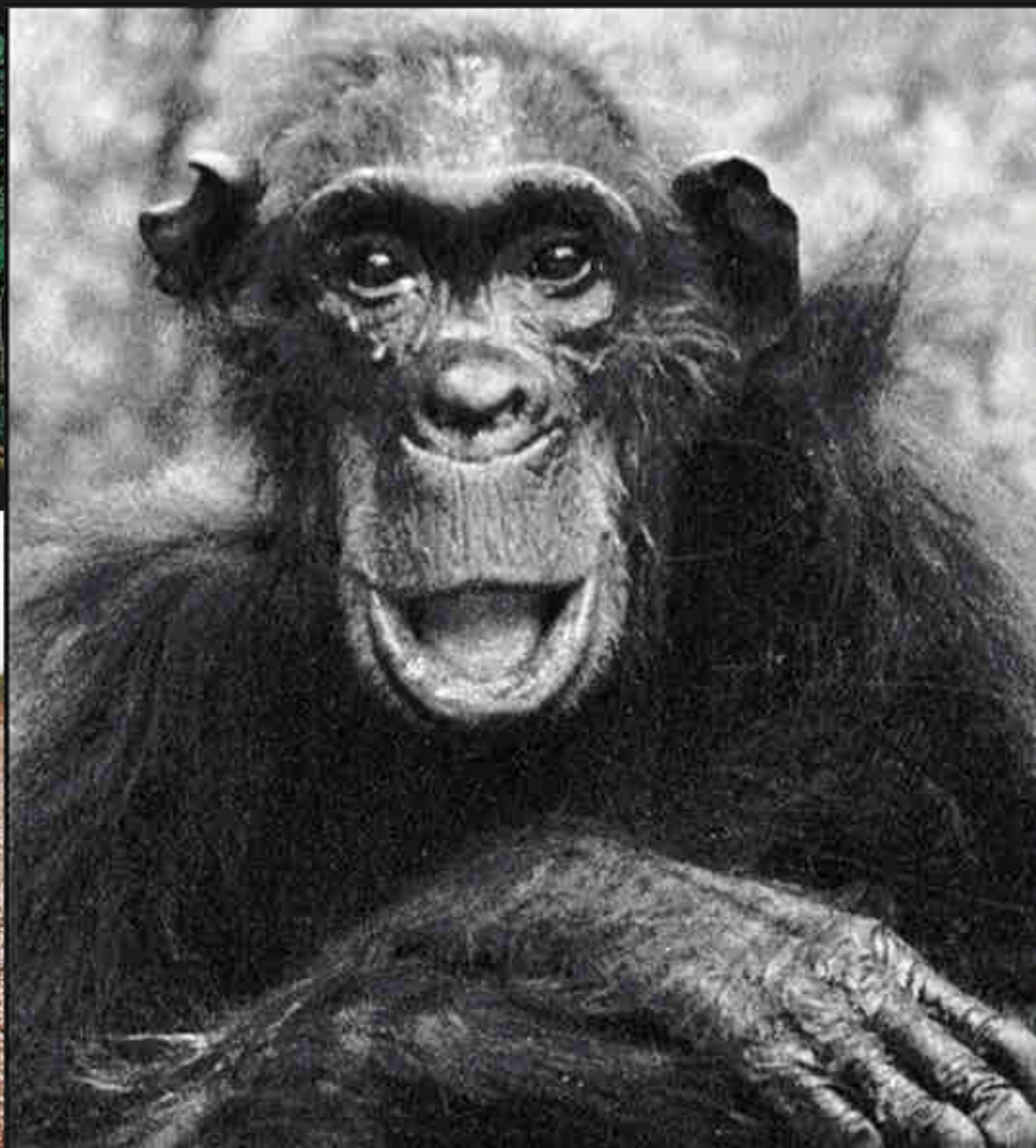
G. 2010



H. 1970



J. 2003



R. 1971



K. 2003



P. 2006

Q. 1995

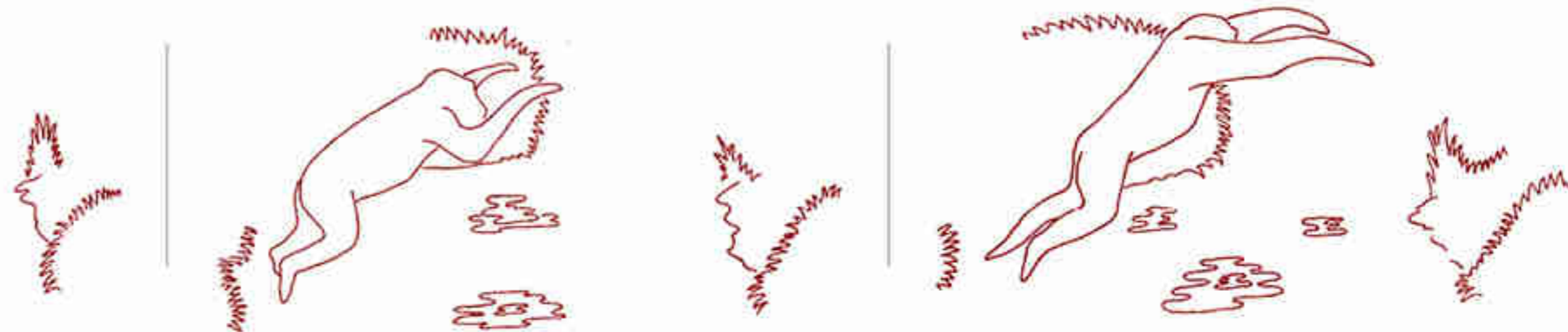
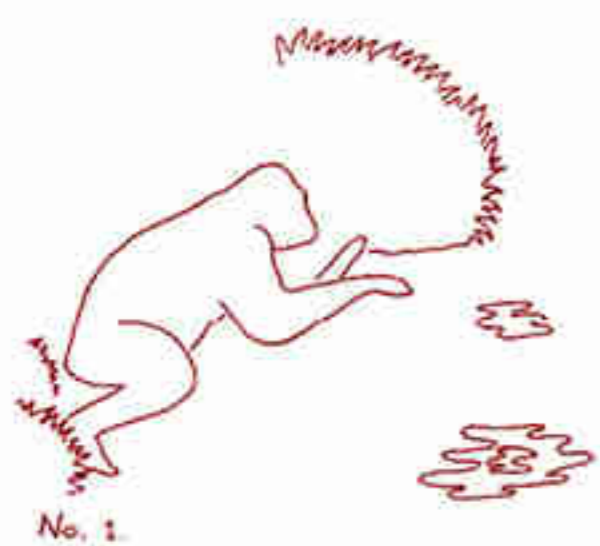


T. 2006



U. 1961





**CHIMPANZEES AGGRESSIVELY COMPETE FOR LAND**

*Published in 1979*

Neighboring chimpanzee communities live in a permanent state of hostility; battles can be deadly.

**CHIMPANZEES MATURE SLOWLY, LIVE LONG, AND REMAIN FERTILE LATE IN LIFE**

*Published in 1979*

Though many aspects of chimp aging mirror those of humans, female chimps do not experience menopause.

**MALE CHIMPANZEES STAY IN NATAL GROUP; FEMALES LEAVE**

*Published in 1979*

Unlike most mammals, males stay in and defend their birth community for life, while females often join a new group before breeding. Transfer reduces inbreeding.

**FEMALE CHIMPANZEES HAVE THEIR OWN HIERARCHIES**

*Published in 1997*

Males dominate overall, but female rank matters: High rank is associated with improved infant survival, shorter birth intervals, and faster maturing daughters.

**CHIMPANZEES GET INFECTED BY A SIMIAN FORM OF AIDS**

*Published in 2009*

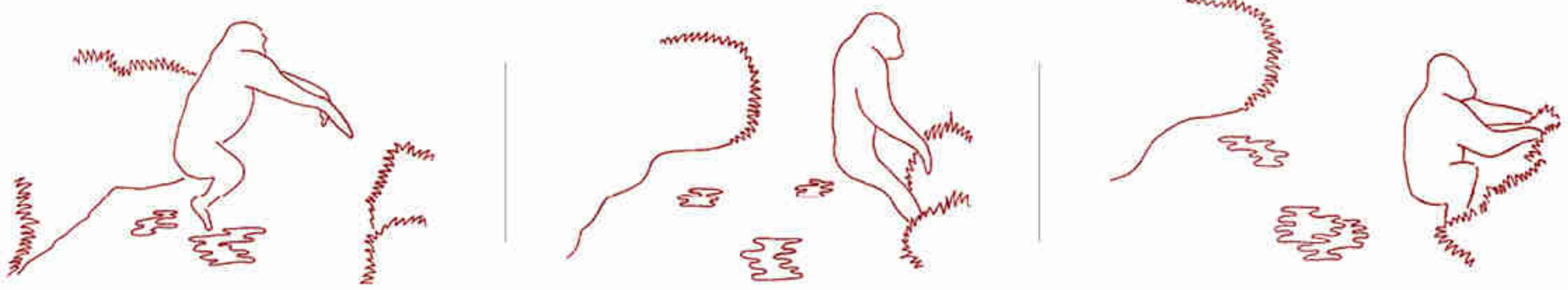
Chimpanzees are natural hosts for the precursor to HIV-1. Some develop AIDS-like symptoms and die early.

more than about a hundred chimpanzees. By all the standards of conservation biology, it wasn't enough to constitute a viable population for the long term—not enough to ensure against negative effects of inbreeding, and not enough to stand steady against an epidemic caused by the next nasty bug, which might be more transmissible than polio, more lethal than flu. Something had to be done, Jane realized, besides continued study of a fondly regarded population of apes that might be doomed. Furthermore, something had to be done for the people as well as for the chimps.

In a nearby town she met a German-born agriculturist, George Strunden, and with his help created TACARE (originally the Lake Tanganyika Catchment Reforestation and Education project), whose first effort, in 1995, established tree nurseries in 24 villages. The goals were to reverse the denudation of hillsides, to protect village watersheds, and maybe eventually to reconnect Gombe with outlying patches of forest (some of which also harbor chimpanzees) by helping the villagers plant trees. For instance, there's a small population of chimps in a patch of forest called Kwitanga, about ten miles east of Gombe. To the southeast, about 50 miles, an ecosystem known as Masito-Ugalla supports more than 500 chimps. If either area could be linked to Gombe by reforested corridors, the chimps would benefit from increased gene flow and population size. Then again, they might be hurt by sharing diseases.

By any measure, it's a near-impossible challenge. Proceeding carefully, patiently, Jane and her people have achieved some encouraging gains in the form of community cooperation, decreased burning, and natural forest regeneration.

**O**N THE SECOND MORNING OF MY GOMBE visit, along a trail not far above the house in which Jane has lived intermittently since the early 1970s, I encountered a group of chimpanzees. They were noodling their way cross slope on a relaxed search for breakfast, moving mostly on the ground, but occasionally up into a Vitex tree to eat the small purple-black berries, and were seemingly indifferent to my presence and that of the Tanzanian researchers. They included some individuals whose names, or at least their family histories, were familiar. Here was Gremlin (daughter of Melissa, a young female when Jane first arrived), Gremlin's daughter Gaia (with a clinging infant), Gaia's younger sister Golden, Pax (son of the notoriously cannibalistic Passion), and Fudge (son of Fanni, grandson of Fifi, great-grandson of Flo, the beloved, ugly-nosed matriarch famous from Jane's early books). Here also was Titan, a very large male, 15 years old, and still rising toward his prime. The



A 1965 series of Jane's tracings from filmstrips show chimp locomotion—a leap over a stream.

rules at Gombe National Park say that you must not approach closely to a chimpanzee, but the tricky thing on a given day is to keep the chimps from approaching closely to you. When Titan came striding up the trail, burly and confident, we all squeezed to the edge and let him swagger past, within inches. A lifetime of familiarity with innocuous human researchers, their notebooks, and their check sheets, has left him blasé.

Another reflection of casualness: Gremlin defecated on the trail not far from where we stood, and then Golden too relieved herself. Once they had ambled away, a researcher named Samson Shadrack Pindu pulled on yellow latex gloves and moved in. He crouched over Gremlin's dollop of fibrous olive dung, using a small plastic scoop to transfer a bit into a specimen tube, which he labeled with time, date, location, and Gremlin's name. The tube contained a stabilizing liquid called RNAlater, which preserves any RNA (from, for instance, a retrovirus) for later genetic analysis. That tube and others like it, representing one fecal sample every month from as many chimps as possible, were destined for the laboratory of Beatrice Hahn at the University of Alabama in Birmingham, who for ten years has been studying simian immunodeficiency virus at Gombe.

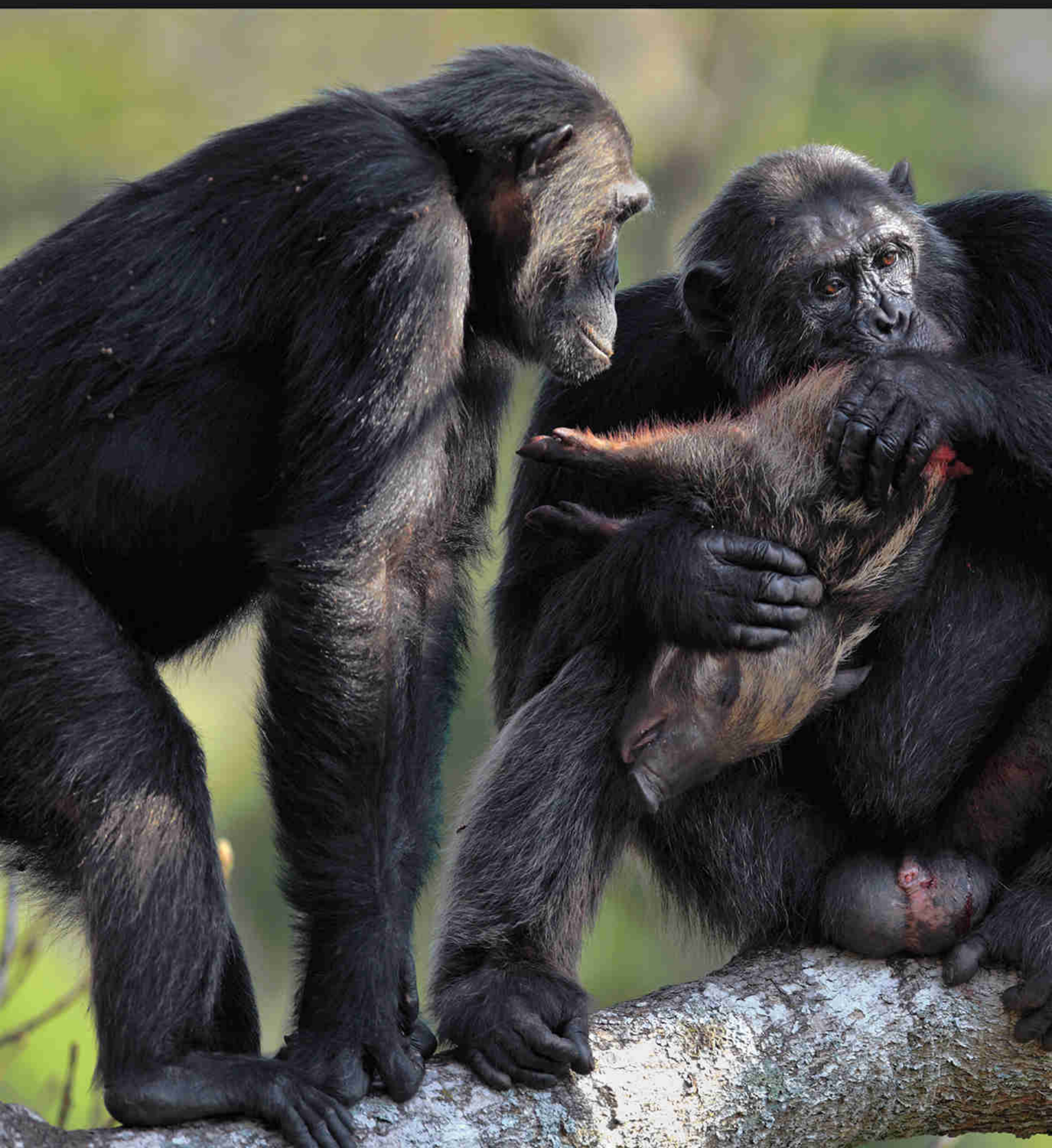
Simian immunodeficiency virus in chimpanzees, known technically as SIVcpz, is the precursor and origin of HIV-1, the virus that accounts for most cases of AIDS around the world. (There is also an HIV-2.) Notwithstanding the name, SIVcpz had never been found to cause immune system failure in wild chimpanzees—until Hahn's expertise in molecular genetics converged with the long-term observational data available at Gombe. In fact, SIVcpz was thought to be harmless in chimps, an assumption that raised questions about how or why it has visited such a lethal pandemic upon humans. Had a few, fateful mutations changed an innocuous chimp virus into a human killer? That line of thought had to be modified after publication of a 2009 paper in the journal *Nature*, with Brandon F. Keele (then at Hahn's lab) as first author and Beatrice Hahn and Jane Goodall among the co-authors. The Keele paper reported that SIV-positive chimps at Gombe suffered between ten times and 16 times more risk of death at a given age than SIV-negative chimps. And three SIV-positive carcasses have been found, their tissues (based on lab work at the molecular level) showing signs of damage resembling AIDS. The implications are stark. An AIDS-like illness seems to be killing some of Gombe's chimps.

Of all the bonds, shared features, and similarities that link our species with theirs, this revelation is perhaps the most troubling. "It's very scary, knowing the chimps seem to be dying at a younger age," Jane told me. "I mean, how long has it been there? Where does it come from? How is it affecting other populations?" For the

**“At Gombe I thought the chimps were nicer than we are. But time has revealed that they can be just as awful.”**

—Jane Goodall

I again observed a group feed  
bushbuck, and was able to watch  
Mr. McGregor who had the complet  
very generous and handed out lump  
and was induced to spit wadges of  
the outstretched hands of two juv  
Mr. McG. out of sight, skin of bu  
approached, reached out, and cont





ing on the carcass of a young  
begging behaviour very closely.  
e hide with legs attached was  
s of flesh to three adults  
chewed meat and leaves into  
veniles. (Sidelight -  
ack hanging down. Female  
ly pull skin. Nothing happens



May 15, 1963

**From: JANE GOODALL**

*Report to National Geo-  
graphic Committee for  
Research and Exploration*

Chimps eat meat!

It was Jane's first big revelation. In 1960 she saw David Greybeard supplementing his plant diet with pig flesh. Later she witnessed chimps hunting. Here in 2007 Frodo (center) gnaws on a pig as two females beg for a taste—a behavior Jane described in her report (above) to the National Geographic Society.

CYRIL RUOSO, MINDEN PICTURES (LEFT);  
NATIONAL GEOGRAPHIC ARCHIVES &  
SPECIAL COLLECTIONS

sincerely,

Jane

**Since 1986 Jane has lived as an advocate, driven by a sense of mission to improve the plight of chimpanzees both captive and wild.**

sake of chimpanzee survival throughout Africa, those questions urgently need to be studied.

But this gloomy discovery also carries huge potential significance for AIDS research in humans. Anthony Collins pointed out that although SIV has been found elsewhere in chimp communities, “none of them is a study population habituated to human observers; and certainly none of them is one which has genealogical information going right back in time; and none is so tame that you can take samples from every individual every month.” After a moment, he added, “It’s very sad that the virus is here, but a lot of knowledge can come out of it. And understanding.”

**T**HE FANCY NEW METHODS OF MOLECULAR genetics bring more than just dire revelations about disease. They also bring the exciting, cheerful capacity to address certain long-standing mysteries about chimpanzee social dynamics and evolution. For instance: Who are the fathers at Gombe? Motherhood is obvious, and the intimate relations between mothers and infants have been well studied by Jane herself, Anne Pusey, and others. But because female chimps tend to mate promiscuously with many males, paternity has been far harder to determine. And the question of paternal identity relates to another question: How does male competition for status within the hierarchy—all that blustering effort expended to achieve and hold the rank of alpha—correlate with reproductive success? A young scientist named Emily Wroblewski, analyzing DNA from fecal samples gathered by the field team, has reached an answer. She found that the higher ranking males do succeed in fathering many chimps—but that some low-ranking males make out pretty well too. The strategy involves investing effort in a consortship—an exclusive period of spending time as a pair, traveling together, and mating—often with younger, less desirable females.

Jane herself had predicted this finding, from observational data, two decades earlier. “The male who successfully initiates and maintains a consortship with a fertile female,” she wrote, “probably has a better chance of fathering her child than he would in the group situation, even if he were alpha.”

Impelled by broader imperatives, Jane ended her career as a field biologist in 1986, just after publication of her great scientific book, *The Chimpanzees of Gombe*. Since then she has lived as an advocate, a traveling lecturer, a woman driven by a sense of public mission. What’s the mission? Her first cause, which arose from her years at Gombe, was improving the grim treatment inflicted on chimpanzees held in many medical research labs. Combining her toughness



and moral outrage with her personal charm and willingness to interact graciously, she achieved some negotiated successes. She also founded sanctuaries for chimps who could be freed from captivity, including many orphaned by the bush-meat trade. That work led to her concerns about human conduct toward other species. She established a program called Jane Goodall's Roots & Shoots, encouraging young people around the world to become active in projects that promote greater concern for animals, the environment, and the human community. During this period she became an explorer-in-residence at the National Geographic Society. She now spends about 300 days a year on the road, giving countless interviews and schoolroom talks, lecturing in big venues, meeting with government officials, raising money to turn the wheels of the Jane Goodall Institute. Occasionally she sneaks away into a forest or onto a prairie, sometimes with a few friends, to watch chimps or sandhill cranes or black-footed ferrets and to restore her energy and sanity.

Fifty years ago Louis Leakey sent her to study chimpanzees because he thought their behavior might cast light on human ancestors, his chosen subject. Jane ignored that part of the mandate and studied chimps for their own sake, their own interest, their own value. While doing that, she created institutions and opportunities that have yielded richly in the work of other scientists, as well as a luminous personal example that has brought many young women and men into science and conservation. It's important to remember that the meaning of Gombe, after half a century, is bigger than Jane Goodall's life and work. But make no mistake: Her life and work have been very, very big. □

Back in the forest in 1995 for "spiritual refreshment," Jane enjoys the company of Pax, arm raised for grooming by his brother, Prof. "When I'm on my own at Gombe now, I can easily recapture how I felt at 26, when all the world was new," she says. "There's still a spiritual power there. I can breathe it in."

# UNDER THE BIG SKY

The image shows a wide, open landscape. The foreground is a golden-brown field, possibly a prairie or a field of wildflowers. In the middle ground, there are rolling hills and mountains, some of which are hazy. The sky is a clear, deep blue, occupying the upper two-thirds of the frame. The overall mood is serene and expansive.

LONE RIDER, TEXAS, 1974

*If there is an image of mine that captures the wide-open West that has so enraptured me, it is this one of a West Texas cowboy at full gallop.*

PHOTOGRAPHS OF THE AMERICAN WEST  
BY WILLIAM ALBERT ALLARD



“DO YOU EVER FEEL LIKE GOING AWAY?” I asked.

It was a summer day in 1969. There had been no rain for weeks. The 17-year-old boy from a Hutterite religious community in Stanford, Montana, said you can tell it’s really dry when a single rider can kick up a dust trail. We stopped with our horses at a stream. The water was cool and tasted of the earth. We drank carelessly, splashing our faces until our shirtfronts hung wet.

“You know—do you ever feel like leaving the colony?”

“No,” the boy said. “It must be a pretty rough life on the outside, all alone, trying to make a living. Don’t you think?”

We let the horses drink, and then rode on.

“Yes,” I told him. “It can be all of that.”

Since that innocent exchange, I’ve spent much of my life traveling the world. I’ve seen a lot of wonderful places. But it was the American West that never left me. It kept drawing me back.

Raised in Minneapolis, I didn’t get my first look at the West until the mid-1960s, while on my first assignments for *National Geographic* magazine. I can still remember one early morning in Wyoming and the first light on high mountain meadows, the wisps of clouds within my reach. That look demanded another, and another, until I found myself seeking any excuse, any story idea that would lead me back from the East, where I had moved, to that grand expanse. Now I live half the year in western Montana.

I once knew an old Montana cowhand, now dead, who used to muse about times when the country was more open, with fewer fences and gates to slow a man down—restrictions in the land of the free. I suppose we all feel more restricted today. There seem to be gates in our lives that we never get open. But if we’re lucky, we find a place special to us. Even though it may change with time, if we love it deeply enough, there is a part of it within us to the end. That’s how I feel about the West. □



#### A RETROSPECTIVE LOOK

William Albert Allard is a 46-year-long contributor. National Geographic Books will publish *William Albert Allard: Five Decades* in mid-October. A companion exhibition will open December 2 at Steven Kasher Gallery in New York City.

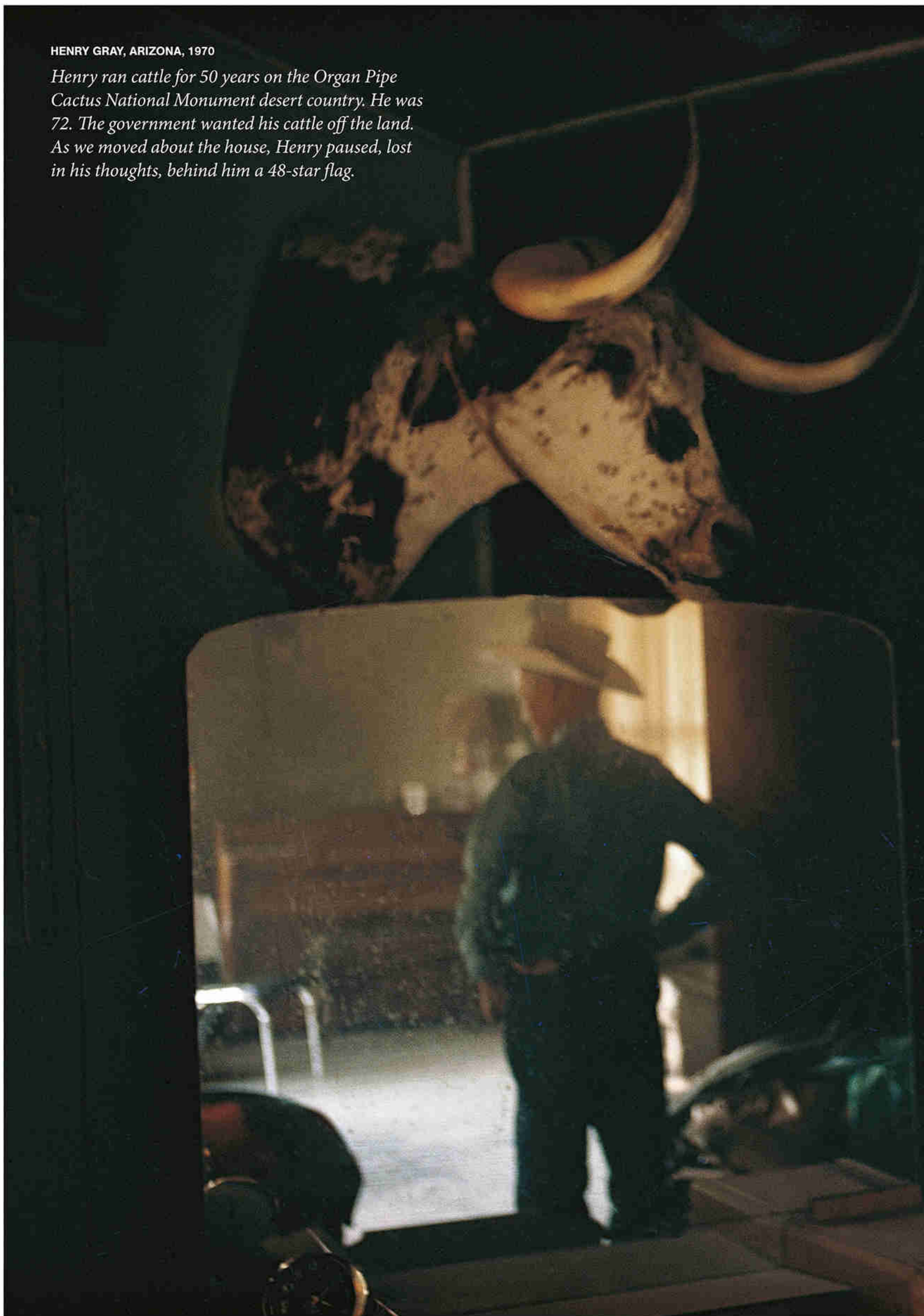


T. J. SYMONDS, NEVADA, 1979

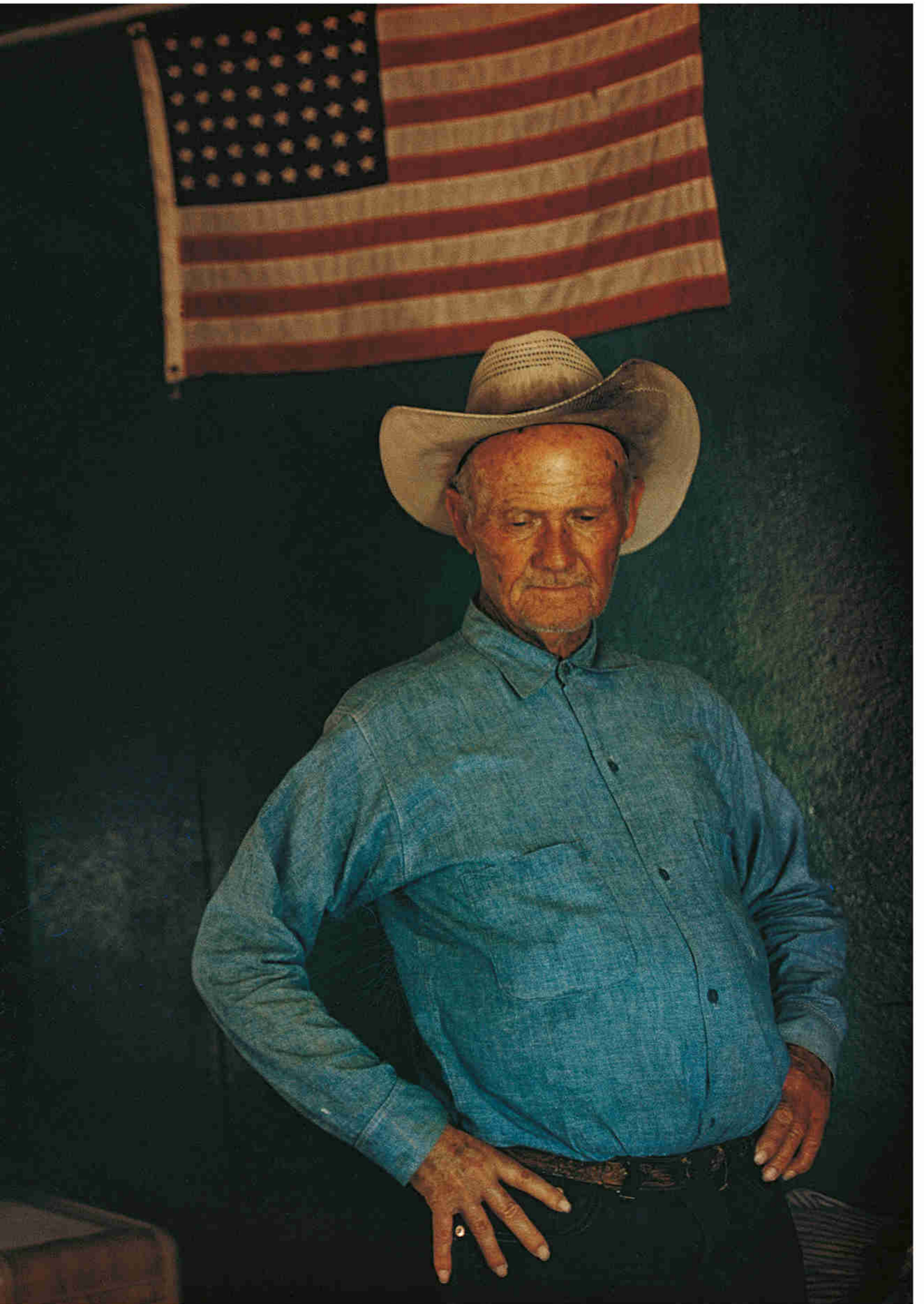
*T. J. was 17 when I met him in a cow camp. He hadn't been doing too well at school and couldn't stay out of trouble, so his dad sent him to the IL Ranch in Nevada to be a buckaroo. Here he's got two slabs of camp-made bread slathered with peanut butter and pancake syrup.*

HENRY GRAY, ARIZONA, 1970

*Henry ran cattle for 50 years on the Organ Pipe  
Cactus National Monument desert country. He was  
72. The government wanted his cattle off the land.  
As we moved about the house, Henry paused, lost  
in his thoughts, behind him a 48-star flag.*











SURPRISE CREEK COLONY, MONTANA, 2005

*Suspended momentarily under a vast gray sky, these children of my lifelong Hutterite friends find joy in simple pleasures. On this communal ranch the older children play ball on a makeshift field, the fenceless outfield stretching out forever.*



CLOUD 9 BAR, NEVADA, 1979

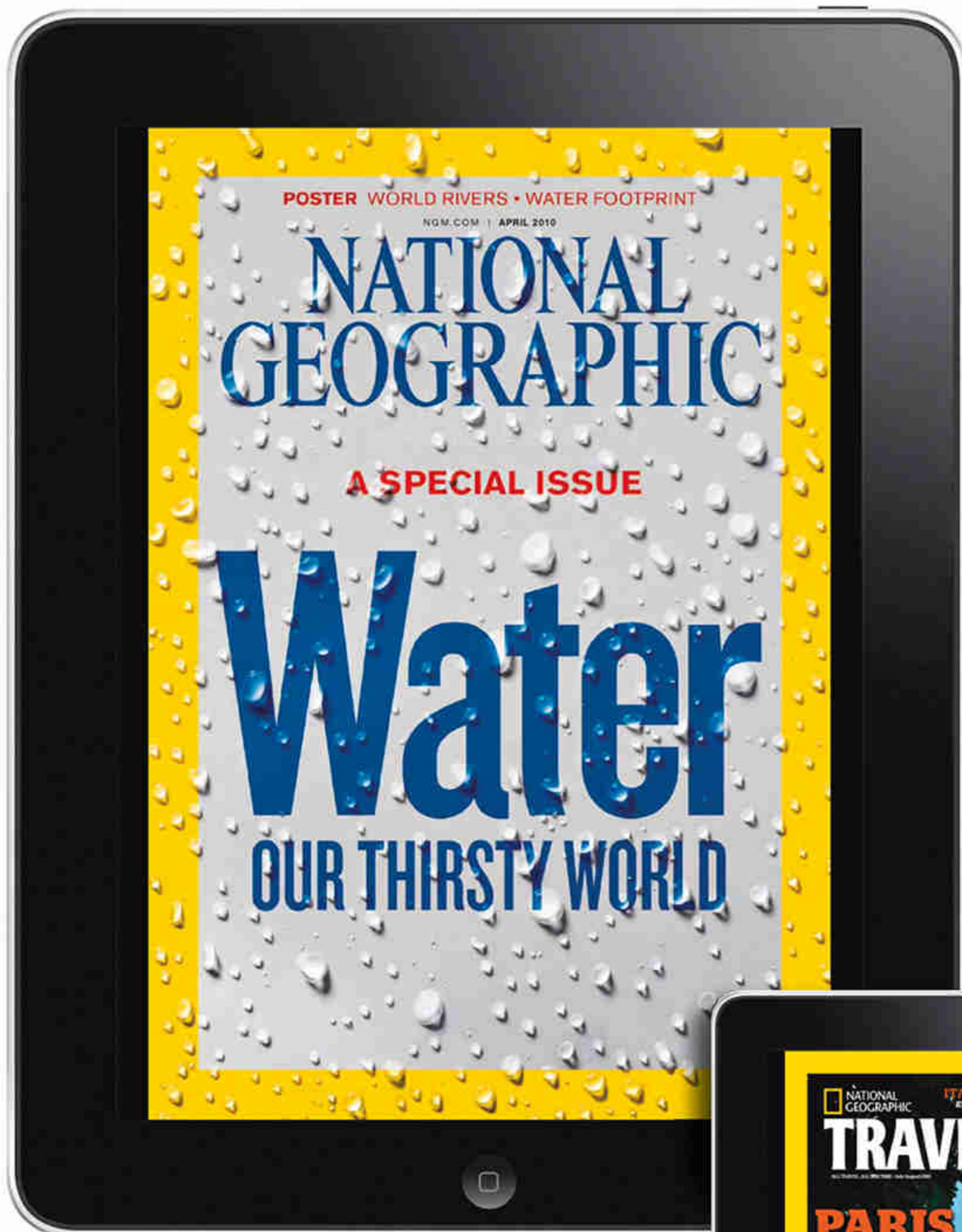


STAN KENDALL, NEVADA, 1979

*I've always liked bars. The glowing, jelly-colored lights and dreamlike name reflected at night beckoned me in Elko (left), a favorite cow town of mine. In Mountain City a buckaroo had that leaving look and did so the next morning.*

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## If you have or had drywall purchased from Lowe's, you could get a payment from a class action settlement.

A settlement has been reached with Lowe's Home Centers, Inc. and Lowe's HIW, Inc. (together called "Lowe's"), about whether certain drywall sold by Lowe's was allegedly defective and caused property damage and personal injury.

### What is this about?

The lawsuit claims that certain drywall sold at Lowe's was defective because it contained high levels of sulfur and/or other organic compounds. The drywall is alleged to emit sulfide gasses and other chemicals. The lawsuit claims the defective drywall leads to: "rotten egg-like" odors; corrosion of air-conditioners, refrigerators, electrical wiring and other metal surfaces and items; and also causes physical irritation and health hazards. Lowe's denies that it sold defective drywall and denies that any drywall it sold caused any damage.

### Who is included?

The Settlement Class includes persons in the United States who (1) purchased, installed or had installed defective drywall from Lowe's anytime before July 27, 2010, or (2) who were owners and/or residents of real property in which defective drywall that was purchased from Lowe's anytime before July 27, 2010, was installed.

### What does the Settlement provide?

The settlement establishes a \$6.5 million Class Fund to pay three kinds of claims.

**No Proof of Purchase:** Class Members who cannot provide documentation of a purchase of allegedly defective drywall from Lowe's are eligible to receive a \$50 Lowe's gift card.

**Proof of Purchase:** Class Members who can provide independent proof that they purchased allegedly defective drywall from Lowe's may be eligible to receive a \$250 Lowe's gift card.

**Proof of Purchase and Damages:** Class Members who can provide independent proof of their purchase of drywall from Lowe's and of resulting damages may be eligible to receive a \$2,000 Lowe's gift card and cash reimbursement of up to \$2,500.

### How do you ask for benefits?

To ask for a payment, you must complete and submit a Claim Form. You can get a Claim Form at [www.DrywallSettlement.info](http://www.DrywallSettlement.info) or by calling 1-877-497-3512. The claim deadline will be no earlier than **May 18, 2011**.

### Your other options.

If you do not want to be legally bound by the settlement, you must exclude yourself from the Class by **November 9, 2010**, or you will not be able to sue, or continue to sue, Lowe's about the legal claims this settlement resolves, ever again. If you stay in the Class (do not exclude yourself), you may object to the settlement by **November 9, 2010**. The detailed notice explains how to exclude yourself or object.

The Court will hold a hearing on November 19, 2010, to consider whether to approve the settlement, and to consider a request by Class Counsel for attorneys' fees, costs, and expenses not to exceed \$2.166 million. Class Counsel will also request an incentive award to the Representative Plaintiff of \$5,000. You or your own lawyer, if you have one, may ask to appear and speak at the hearing at your own cost, but you do not have to.

More information about your rights and options and how to exercise them is available at the website and toll free number.

**[www.DrywallSettlement.info](http://www.DrywallSettlement.info)  
1-877-497-3512**



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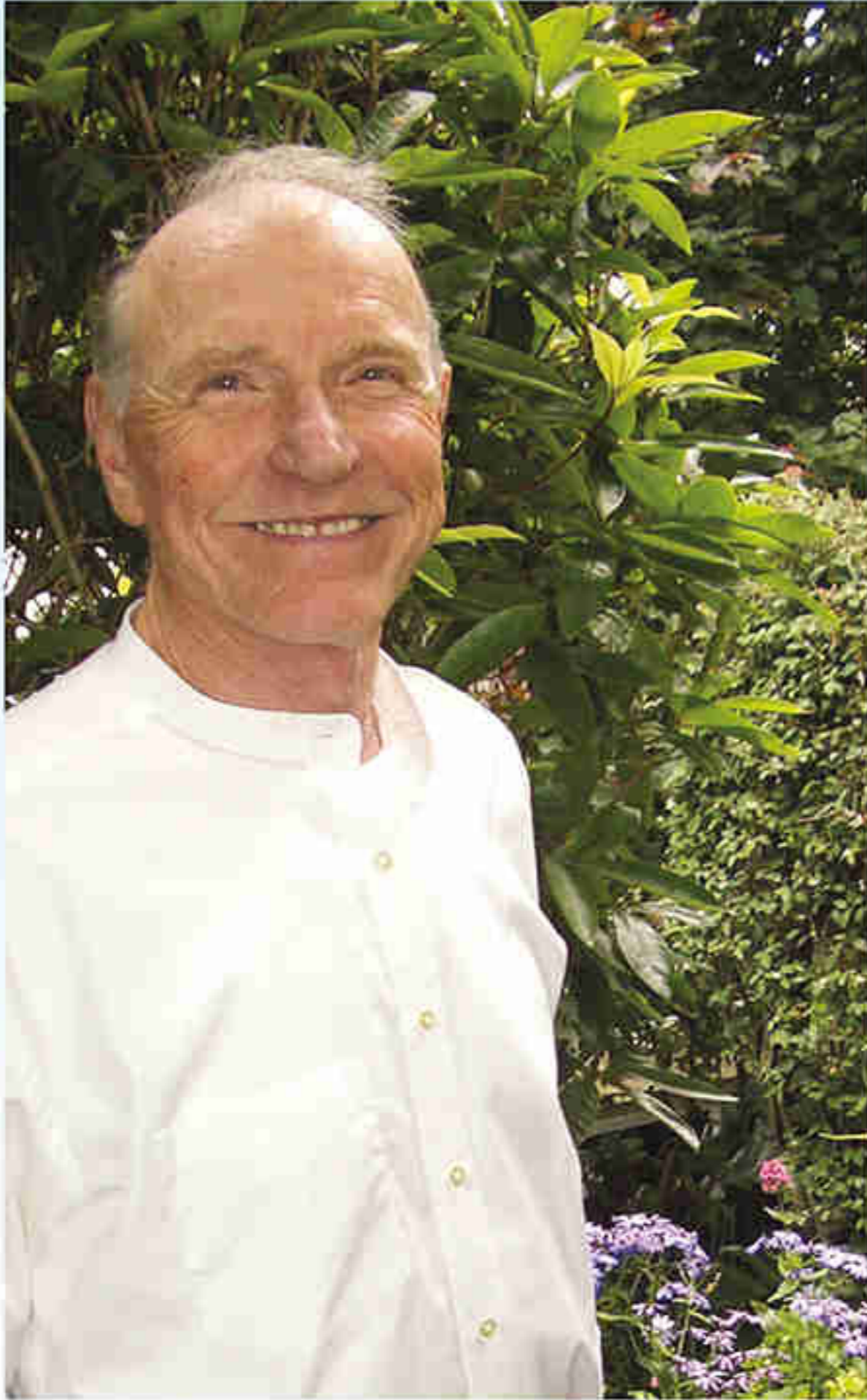
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John McCallister included National Geographic in his estate plans.



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An avid traveler and horticulturist, John McCallister was introduced to National Geographic when his aunt sent him a gift subscription to the magazine in the 1940s. "I like everything about National Geographic, what it stands for, and what it accomplishes," John says.

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👉 **Flashback Archive** Find all the photos at [ngm.com](https://ngm.com).

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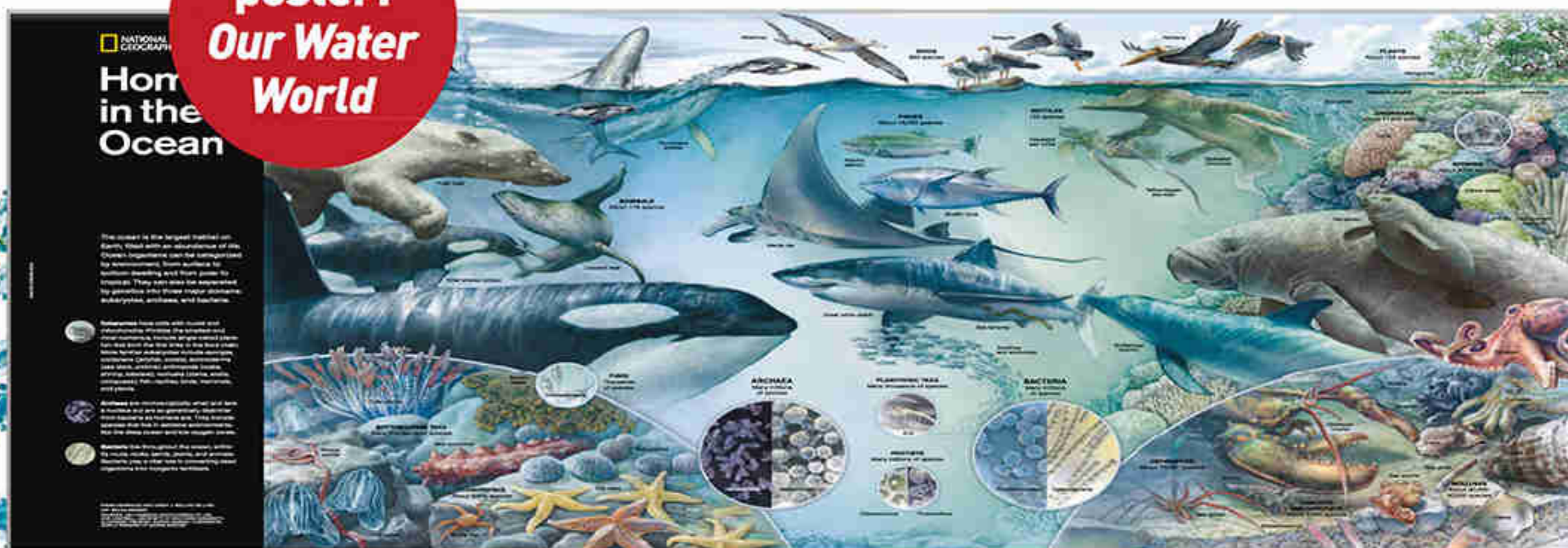
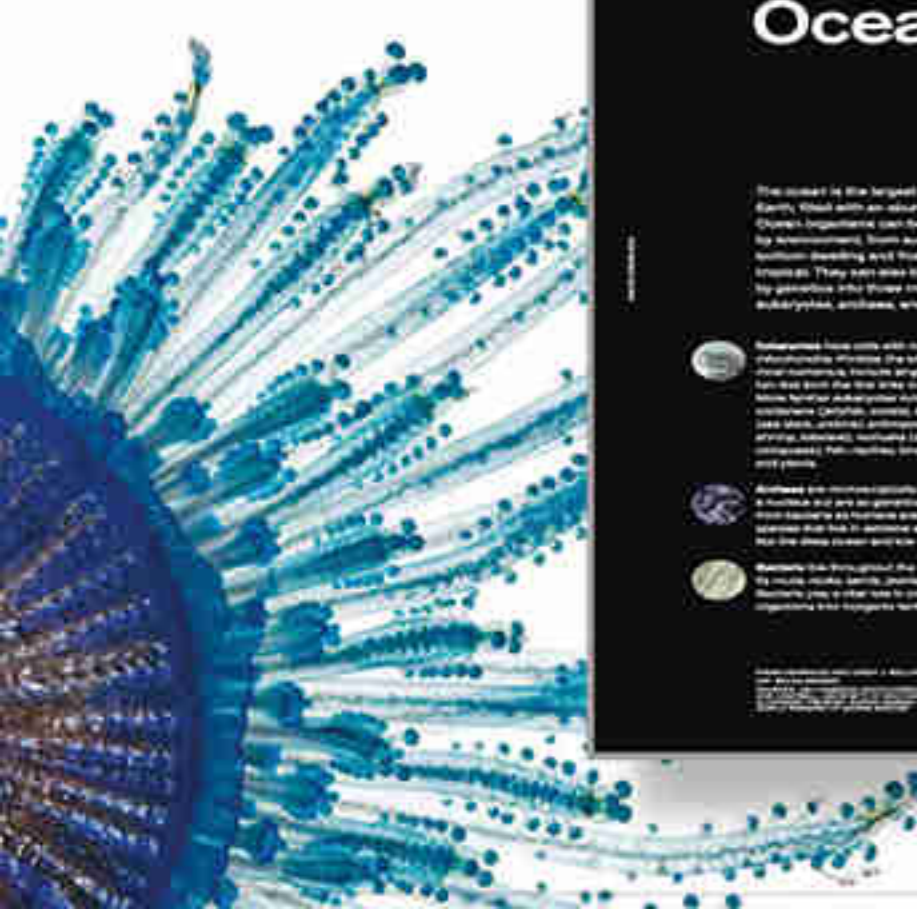
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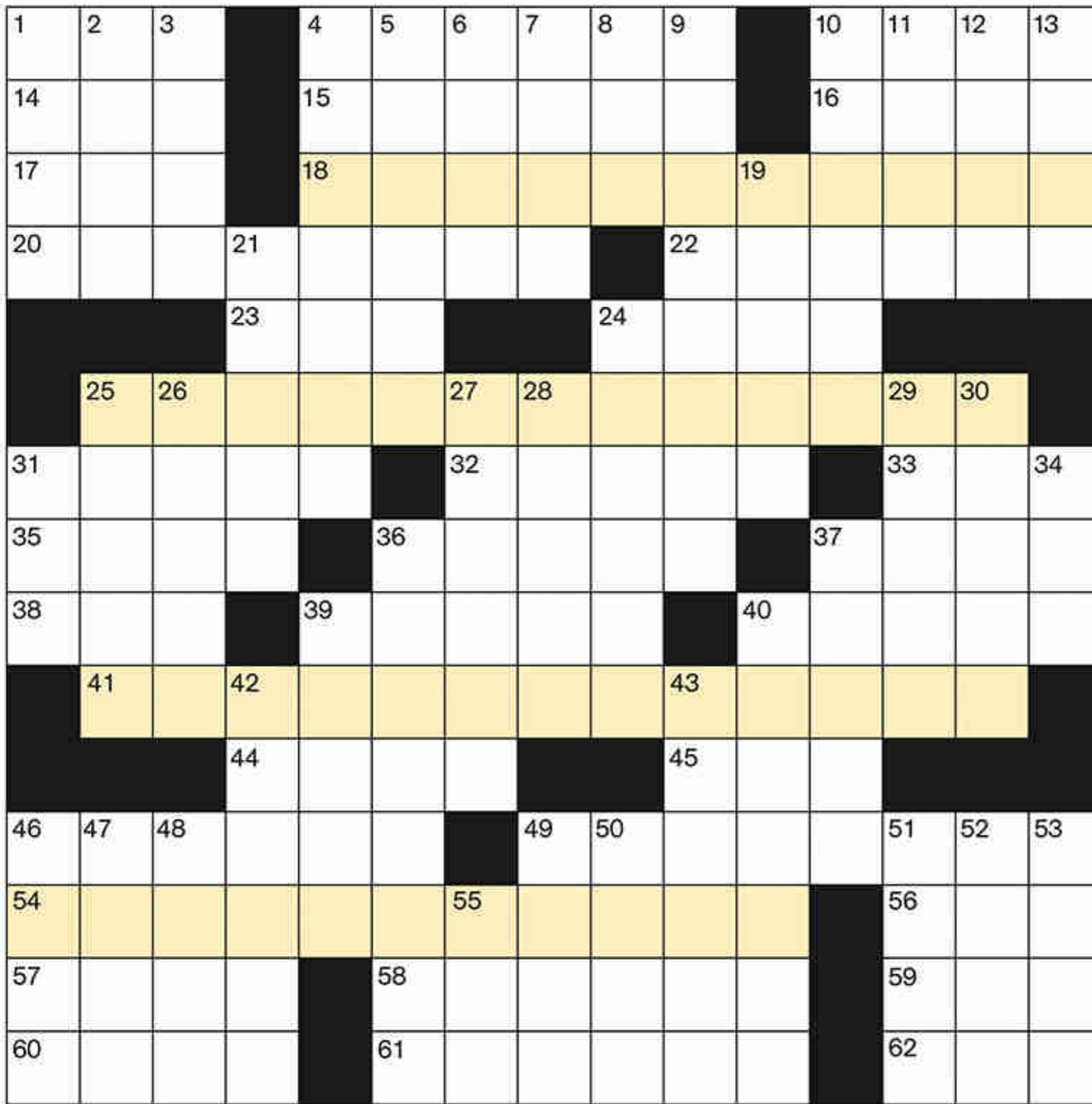
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# GEOPUZZLE



## Wild Fish

Puzzle by Cathy Allis

How do you weigh the impact of eating fish? SeafoodPrint, a new study supported by the Pew Charitable Trusts and National Geographic (page 78), addresses the cost of wild and farmed seafood. GeoPuzzle also addresses fish in its tinted answers, but as you will see, they are wild in an unexpected way.

### ACROSS

- 1 Wellness resort
- 4 Flat dweller
- 10 Goya subject, naked and clothed
- 14 Panama, e.g.
- 15 Camden Yards ballplayer
- 16 Track shape
- 17 Before now
- 18 Physician-sourced nutritional supplement?
- 20 Like some fish populations
- 22 With uniformity
- 23 Righteous Babe Records creator DiFranco
- 24 French Polynesia components

- 25 It's among a cannibal's family recipes, literally?
- 31 Shafts between wheels
- 32 Get hitched
- 33 Ring bearer?
- 35 Bass parts
- 36 Hemingway and Haydn, nicknamewise
- 37 Contributed
- 38 Genetic messenger
- 39 Wong of book and film titles
- 40 Ran on TV
- 41 Willy's *Death of a Salesman* kin given the third degree?
- 44 Canasta objective

- 45 *Saving Fish From Drowning* author Amy
- 46 How freelancers may work
- 49 Peter and Paul, but not Mary
- 54 Steak shared by a couple with the same summer sign?
- 56 Bowl over
- 57 Privy to
- 58 Entertain abundantly
- 59 Male that mews
- 60 \_\_\_ off (offended)
- 61 Male mallards
- 62 Emulate Bode and Lindsey

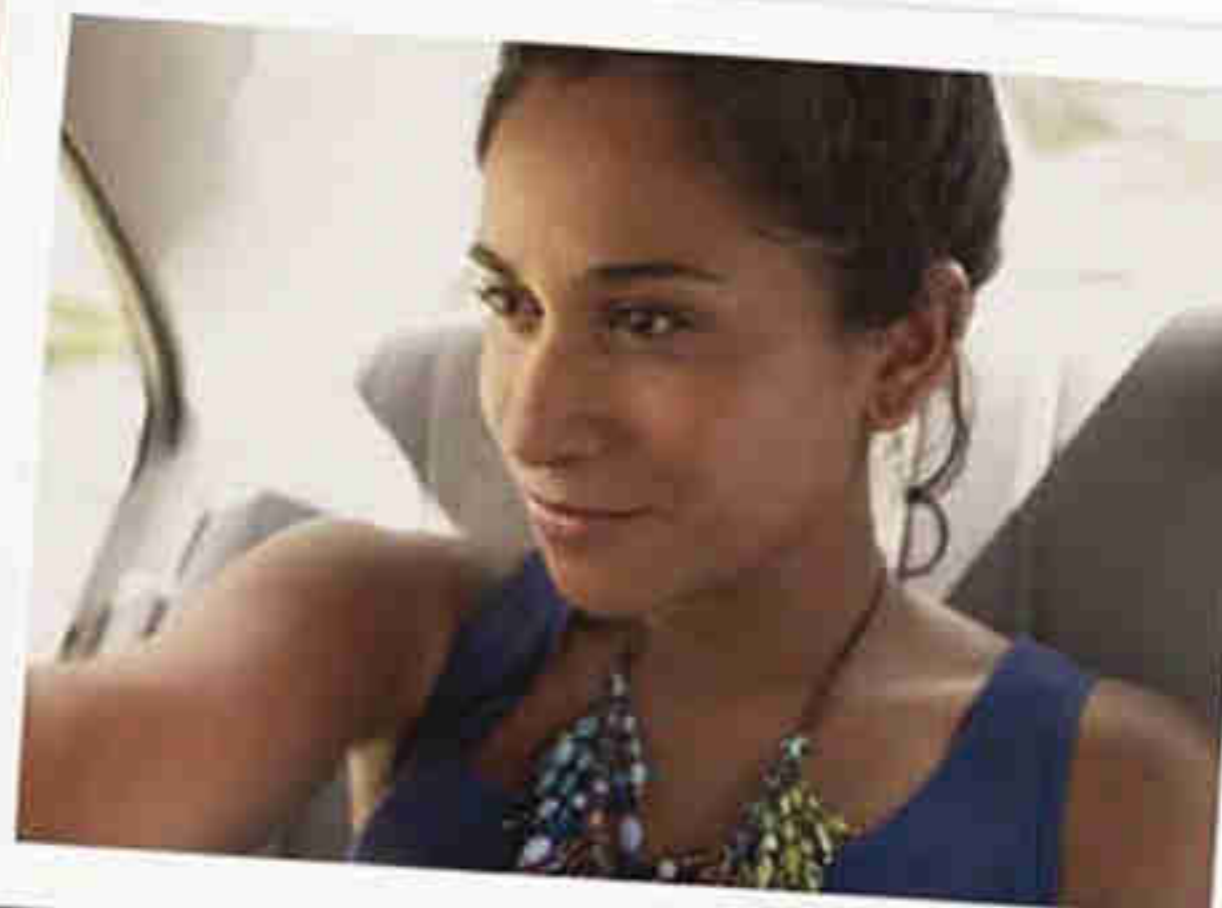
### DOWN

- 1 Its roe are a delicacy
- 2 Summons with a beeper
- 3 Straddling
- 4 Gophers' group
- 5 Like the *Kama Sutra*
- 6 "Well played!"
- 7 Betrayed a secret
- 8 Collegian in the Whiffenpoofs
- 9 Merrymakers
- 10 To a greater extent
- 11 The Bard's river
- 12 Big house
- 13 One on your side
- 19 Each's partner
- 21 Some have gutters
- 24 The Mossad's country
- 25 Letting go
- 26 Of a forearm bone
- 27 Bowled over
- 28 Flavorful
- 29 Find out
- 30 Icicle sites, often
- 31 Cameroon's cont.
- 34 Word with snapper or herring
- 36 Dangling ceiling-fan part
- 37 Leviathan
- 39 Wintry weather woe
- 40 Stockpiles
- 42 Loom
- 43 Burton's *Becket* co-star
- 46 For the heck \_\_\_
- 47 Muse count
- 48 Berry of the blackthorn
- 49 Bottom bit of the seafood chain
- 50 Pikes, e.g.
- 51 Back muscles, briefly
- 52 Furry Jedi friend
- 53 Tractor-trailer combo
- 55 Slangy ending for two or go

Answers in  
*Inside Geographic*



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Susie Abraham  
2010 Corolla Owner



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Thanks for your story, Susie!



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